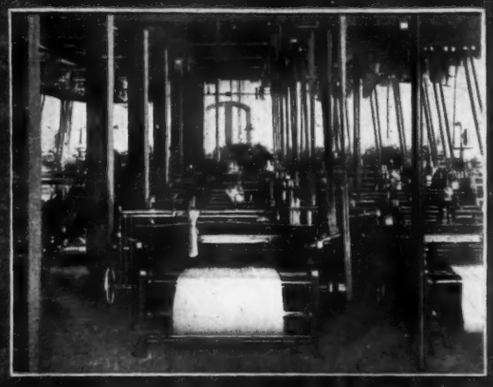
PUBLIC LIBRARY — OF THE — CITY OF DETROIT

POWER

Volume 35, No. 20.
Issued Every Tuesday.
Hill Publishing Company.

NEW YORK, MAY 14, 1912.

Price, 5 cents.
Outline of Topics, 52.
Index to Advertisers, 42.



RHOADS TANNATE BELTS

TANNATE BELTING

SAVINGS IT EFFECT

The right belt saves you money in various ways. It will reduce the common loss from slippage. This, in turn, increases the output. These savings Tannate Belt gives you, as previously noted. But it also often reduces your belt bills. We have lots of proof that it does this on hard drives. Here are two cases:—

A Tannate Belt installed about 16 months ago has already outworn one oak and two Balata belts.

A box company in Baltimore on whose planers belts had never lasted more than a year now have a Tannate Belt which has been running on a planer over two years.

The reason lies in the toughness given by the tannage, also in the flexibility and grip which prevent the belt from slipping and burning out. It lies further in the uniformity of strength, that is, the freedom from weak spots which results from our very careful assortment of the leather.

So Tannate costs less per year. Try some on your next need and prove it. Write us for the address of the nearest dealer.

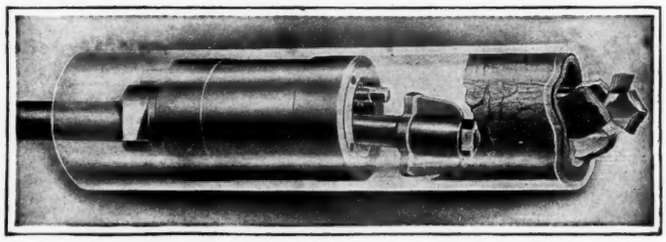
J. E. RHOADS & SONS

PHILADELPHIA
12 N. Third St.

NEW YORK
102 Beekman St.

CHICAGO
322 W. Randolph St.

Factory and Tannery, Wilmington, Del.



The Dean Removing Scale from the Tube of a Water Tube Boiler.

Let Us Loan You A Dean For A Thorough Trial In One Boiler

If we can't prove that you do have scale in spite of what you may now be doing to combat it, and

If we can't prove that the Dean removes scale more thoroughly, with greater ease, in less time, at smaller cost, than any other device on the market, you may box it up and return it at our expense.

This is not a bluff to create a favorable impression—not a proposition with a string to it—

It's a straight proposition that thousands of steam users have investigated—and found profitable.

One man, for instance, writes us that the use of the Dean has enabled him to save $50.00 a month—the tribute he formerly paid to the compound man.

Another man—an engineer—says the Dean reduced the coal bill $4.00 a week on two boilers.

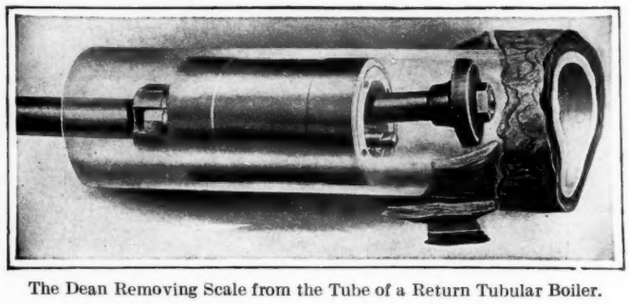
The manager of one of the largest lumber manufactories on the Pacific Coast states that the Dean put a stop to leaky tubes—a trouble which the engineer had been unable to overcome.

Why not send for a Dean today?

The Wm. B. Pierce Company

CHICAGO OFFICE
801 Steinway Building

Jewett Bldg., Buffalo, N. Y.



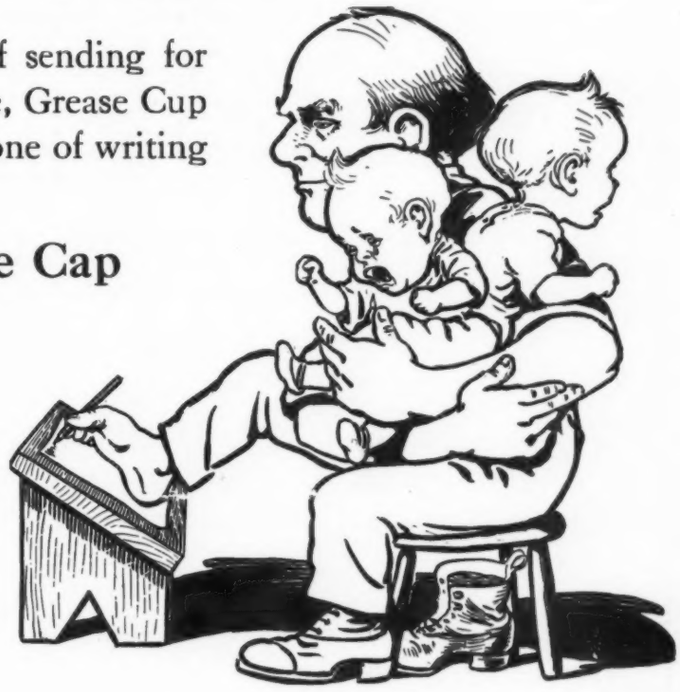
The Dean Removing Scale from the Tube of a Return Tubular Boiler.

KEYSTONE GREASE

KEYSTONE TRADE MARK REGISTERED U.S. PAT. OFF.

Even If Your Hands Are Full

DON'T let that stand in the way of sending for the free Can of Keystone Grease, Grease Cup and Cap. There are more ways than one of writing a letter.



The Grease, The Cup, The Cap

All are worth getting—but especially the Grease. For your engine room is going to be a revelation to you when you start putting Keystone on the bearings of your engine and machines. It is going to be cleaner. You are going to find it so much less work to get so much better lubrication. Why not try it and see for yourself—it will cost you absolutely nothing.

The coupon brings them all.

KEYSTONE LUBRICATING CO.

Executive Office and Works

21st, Clearfield and Lippincott Streets **Philadelphia, Pa.**

Branch offices and warehouses in the principal cities of the United States.
Agencies in the principal countries throughout the world.

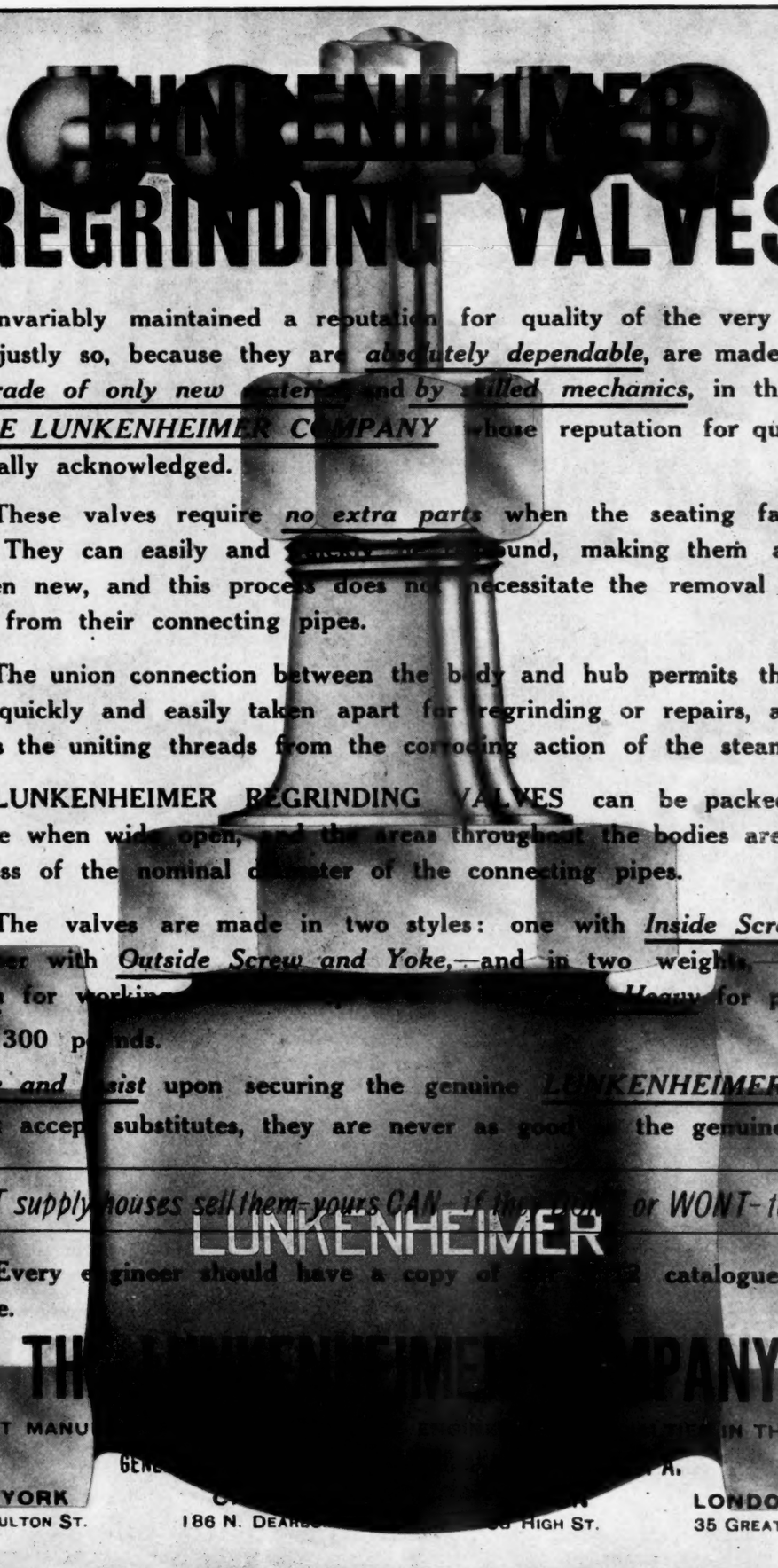
NO CONNECTION WITH THE OIL TRUST

A SAMPLE FREE

KEYSTONE LUBRICATING COMPANY, Phila.

Please send us a large size sample of Keystone Grease, sufficient for testing purposes, and a substantial Grease Cup and Free Engineer's Cap. It is thoroughly understood that no charges whatsoever will be made for sample, cup or cap, and all express charges will be paid by you.

Name of bearing where sample will be tested.....
Its width..... Combined horsepower of engines.....
Tap size of cup .....
FIRM.....
Per .....
City ..... State.....
Size cap required.....**CUT OUT THIS COUPON AND MAIL IT TO-DAY** Dept. B—5-14-12



LUNKENHEIMER REGRINDING VALVES

have invariably maintained a reputation for quality of the very highest,—and justly so, because they are *absolutely dependable*, are made of the *best grade of only new materials* and *by skilled mechanics*, in the shops of *THE LUNKENHEIMER COMPANY* whose reputation for quality is universally acknowledged.

These valves require *no extra parts* when the seating faces are worn. They can easily and [illegible] ground, making them as tight as when new, and this process does not necessitate the removal of the valves from their connecting pipes.

The union connection between the body and hub permits the valve to be quickly and easily taken apart for regrinding or repairs, and also protects the uniting threads from the corroding action of the steam.

LUNKENHEIMER REGRINDING VALVES can be packed under pressure when wide open, and the areas throughout the bodies are largely in excess of the nominal diameter of the connecting pipes.

The valves are made in two styles: one with *Inside Screw* and the other with *Outside Screw and Yoke*,—and in two weights, *Medium Pattern* for working [illegible] *Heavy* for pressures up to 300 pounds.

Specify and insist upon securing the genuine *LUNKENHEIMER make.* Do not accept substitutes, they are never as good as the genuine.

"*MOST supply houses sell them—yours CAN—if they will or WONT—tell US*"

LUNKENHEIMER

Every engineer should have a copy of our [illegible] catalogue. Write for one.

THE LUNKENHEIMER COMPANY

LARGEST MANUFACTURERS OF [illegible] IN THE WORLD

GENERAL OFFICES AND WORKS, CINCINNATI, U.S.A.

NEW YORK
64–68 FULTON ST.

CHICAGO
186 N. DEARBORN ST.

[illegible]
HIGH ST.

LONDON, S. E.
35 GREAT DOVER ST.

3

SMILE

The man with a smile is the man worth while. Nobody likes the grouchy, sour-faced, frowning countenance.

But see a smile, a whole-hearted smile on a man as he goes about his work and—

You naturally take it for granted that his work is pleasant to him—that his work is being done in good shape.

But have you ever seen a smile on the face of an engineer who had to spend a lot of *his own* time cleaning out scale incrusted boilers?

It's no joke to have to tackle a boiler cleaning proposition—

Especially when you know that you'll have to do the same thing week after week.

Why not settle your scale problem in the right way—have your feed water analyzed and Dearborn Treatment prepared to fit your needs?

Then you'll have no more scale, corrosion, pitting, foaming, etc.

You'll save coal, boiler repair cost, time; you'll improve boiler results and make a better personal showing.

Send us a gallon of your feed water for free analysis today.

DEARBORN DRUG & CHEMICAL WORKS

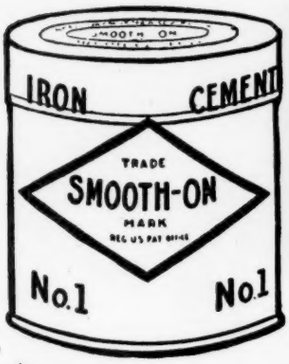
Robert F. Carr, President

General Offices, Laboratory and Works
Chicago

General Eastern Offices, 299 Broadway
New York

Branch Offices In Principal Cities

Catalog on Request

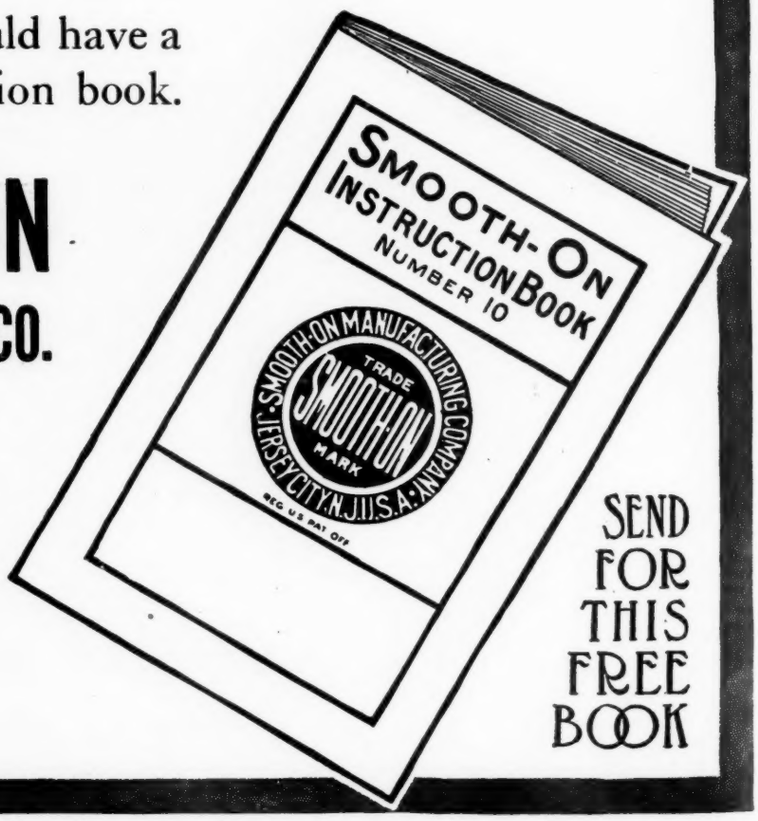


SMOOTH-ON

IRON CEMENTS

Positively stop all leaks of steam, water, fire or oil in iron, steel or concrete. They are easy to apply, harden quickly and make permanent repairs; proved by years in use.

Every engineer should have a copy of our instruction book.



SEND FOR THIS FREE BOOK

SMOOTH-ON MANUFACTURING CO.

Jersey City, N. J.

231 N. Jefferson St., Chicago

36 Sacramento St.
San Francisco, Cal.

8 White St., Moorfields, E.C.
London

POWER

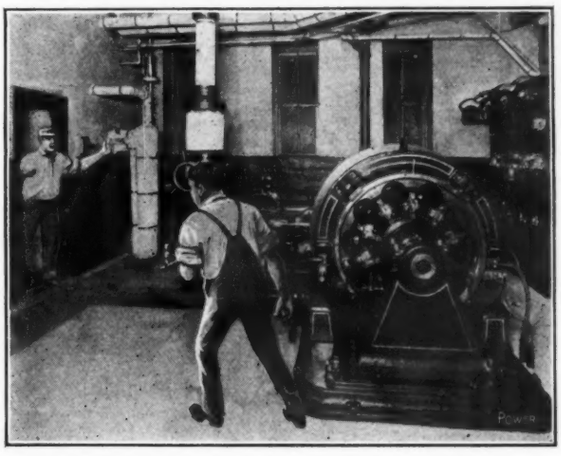
Vol. 35 NEW YORK, MAY 14, 1912 No. 20

THE tendency of most engineers upon taking charge of a steam plant is to show the "old man" what a valuable asset has been added to the establishment.

They feel compelled to disclose the shortcomings of their predecessors, and to point out where changes can be made which will work to the interest of their employers.

Now, ambition to make good is highly commendable, but it can lead an engineer into difficulties and saddle duties upon him which he should not perform.

The engineer has enough to claim his undivided attention in the steam plant without being obliged to go into the factory and care for shafting and belts, or do other mechanical work.



Once there was an engine runner—and he did his own firing—who was ambitious to make a showing, so he persuaded the management to hire a fireman so that he could put in more time in the factory and save the expense of a machinist.

This was done, and the engineer became a "jack-of-all-trades." A lathe was purchased at his suggestion, but he could not turn out good work; he failed to do his part because he was not a trained mechanic. Eventually the fireman was discharged, a machinist was engaged, and the engineer was sent back to the engine and boiler rooms.

It is all very well to try to cut down running expenses, but no man can do two or three men's work and make good.

There are ways of reducing expenses without going out of the engine or boiler rooms, and it does not require the wisdom of a Solomon to detect sources of loss.

It may be that the exhaust of a heating coil is blowing to the atmosphere; then trap it and pump the water back into the boiler.

It may be that the steam pipes are bare; then cover them and prevent excessive condensation and wet steam.

It is more than probable that the blowoff valve is leaking; it does not take much of a leak to waste a large amount of water under a pressure of 100 lb. or more.

Some boiler settings are cracked and air leaking into the furnaces produces poor combustion. It does not take long to stop up the cracks, and careful regulation of the damper and a better method of firing will materially reduce the amount of fuel consumed.

The safety valve may leak steam 24 hours a day; total loss, because no work has been done, although coal has been burned in evaporating the water into steam.

Larger wastes are easily discovered. They are self-evident, but the small sources of loss are usually passed unnoticed, or else are considered of no account.

The place for the engineer to make his showing is in the power plant, not out in the shop. An engineer should not attempt to be general machinist, repair man, or roustabout. If he keeps his engine and boiler in condition, he will have all the work to which he can properly attend.

Aeolian Company's New Power Plant

By Warren O. Rogers

A remodeled high-speed engine plant.

A feature is the method of handling the fuel and ash.

The coal bin is made in two parts, the lower holding a reserve supply of fuel.

A few years ago it was customary for manufacturing companies to pay scant attention to the design of the power plant, and woodworking industries were specially lax in their attention to the power end of the business. Of late years, however, the steam plant has received attention more in keeping with its importance.

The remodeled power plant of the Aeolian Co., at Garwood, N. J., is an example of an uptodate installation for woodworking establishments.

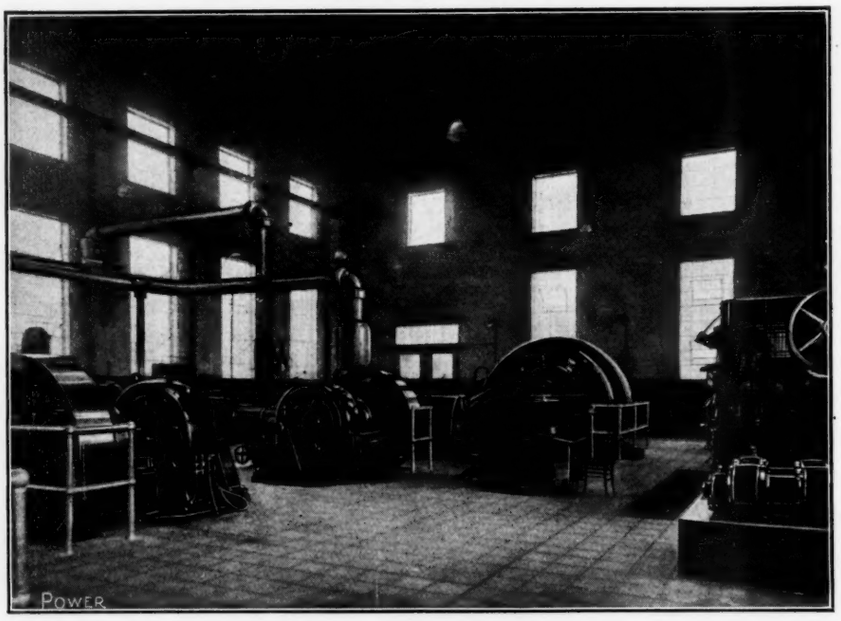


FIG. 1. THREE OF THE FOUR GENERATING UNITS

The power house is constructed of brick with a tar gravel roof. Both engine and boiler rooms are well lighted and a liberal amount of space has been allowed for the machinery throughout the plant.

ENGINE ROOM

A view of the engine room is shown in Fig. 1. There are three 14x14-in. high-speed engines and one cross-compound medium-speed engine having cylinders 20 and 34 by 28 in. These engines are all direct-coupled to 250-volt direct-current generators. The electrical energy is transmitted from the switchboard to the factory for motor and lighting service by means of a three-wire system. Two balancing sets are used to balance the load.

FEED-WATER APPARATUS

Water for the boilers is obtained from a 203-ft. driven well, and the Pohle air-lift system is used. An 8 and 10 by 8-in. air compressor supplies the compressed air for lifting the water which is discharged into a storage reservoir, while the water for factory use is pumped into a 10,000-gal. tank which is mounted on a tower. Either a motor-driven pump or a duplex pump handles the factory water supply, the latter being used when the plant is shut down.

There are two boiler-feed pumps, both of the outside-packed type. The water is heated to 210 deg. F. in passing through an open feed-water heater. There is also an underwriters' fire pump with a maximum capacity of 1000 gal. at 70 r.p.m. per minute. This pump is piped to a concrete reservoir located in the yard which has a water capacity of 148,000 gal.

BOILER ROOM

In the boiler room, shown in Fig. 2, there are three 400-hp. water-tube boilers which carry a steam pressure of 165 lb., the steam being superheated 100 deg. The furnaces are controlled by a balanced draft system. The necessary air is supplied to the furnaces by a fan, shown in Fig. 3, which is driven by one of two engines, one of which is uncoupled and held for emergency use. The speed of the fan engine is controlled by a damper regulator which is governed by the steam pressure. The smoke and gas of combustion pass from the boilers through a square steel flue to a brick chimney which is built in and at the end of the present boiler house. The stack foundation is constructed of concrete; Fig. 3 shows the base.

The position of the chimney provides for future extension of the boiler room,

FIG. 2. THE BOILER ROOM, SHOWING FORCED-DRAFT UNIT AT THE RIGHT

in which case the chimney would receive the gases from the boilers from each side.

Coal Conveyors

Probably the most interesting feature of the plant is the method of handling the coal and ashes. A concrete coal bunker has been built on the outside of the boiler house, the inside wall forming the boiler-room wall, which is at the left in Fig. 2. The outside construction of the coal bunker and ash bin is shown in Fig. 4. Coal is delivered to the bucket coal conveyor from coal cars which discharge the fuel into the conveyor hopper that is located at the end of the coal bunker out in the yard.

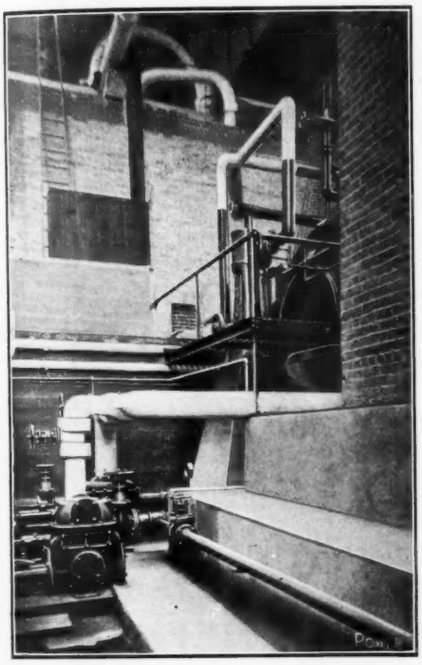


Fig. 3. A View of the Stack Pit

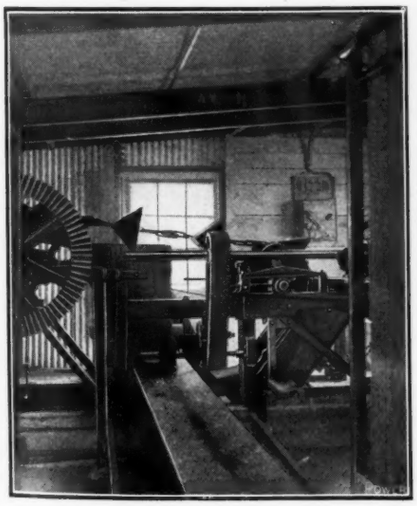


Fig. 5. Junction of Bucket and Belt Coal Conveyors

The bucket conveyor runs in a metal casing on the outside of the bunker and discharges onto an endless belt conveyor, shown in Fig. 5. The belt conveyor runs at right angles to the bucket conveyor and the coal is discharged into openings which lead to the several pockets into which the bunker is divided. The openings and the discharge chute of the conveyor are shown in Fig. 6. Both conveyors are motor driven.

There are five sections to the coal bunker and each is provided with an overflow from the top to the bottom pockets, into which the bunker is divided by a concrete partition sloping from the back toward the front of the bunker, as shown in Fig. 7. When the top pocket has been filled to the level of the opening of the overflow, all additional coal drops through the overflow chute to the bottom of the bunker; and is held in reserve. In case the delivery of a cargo of coal is delayed, this reserve supply can be drawn upon and elevated to the top bunker by means of a belt conveyor which runs in a tunnel on the outside of the coal bunker. An opening in each pocket has been provided for this purpose.

In case it is desirable to empty the upper bunker, a gate has been provided in the slanting concrete partition. The top coal bunkers have a capacity of 730 tons, and the lower bunkers 540 tons. Coal is delivered from the top bunkers, through chutes to a metal coal car which runs on an industrial track. The plan view, Fig. 8, shows the layout.

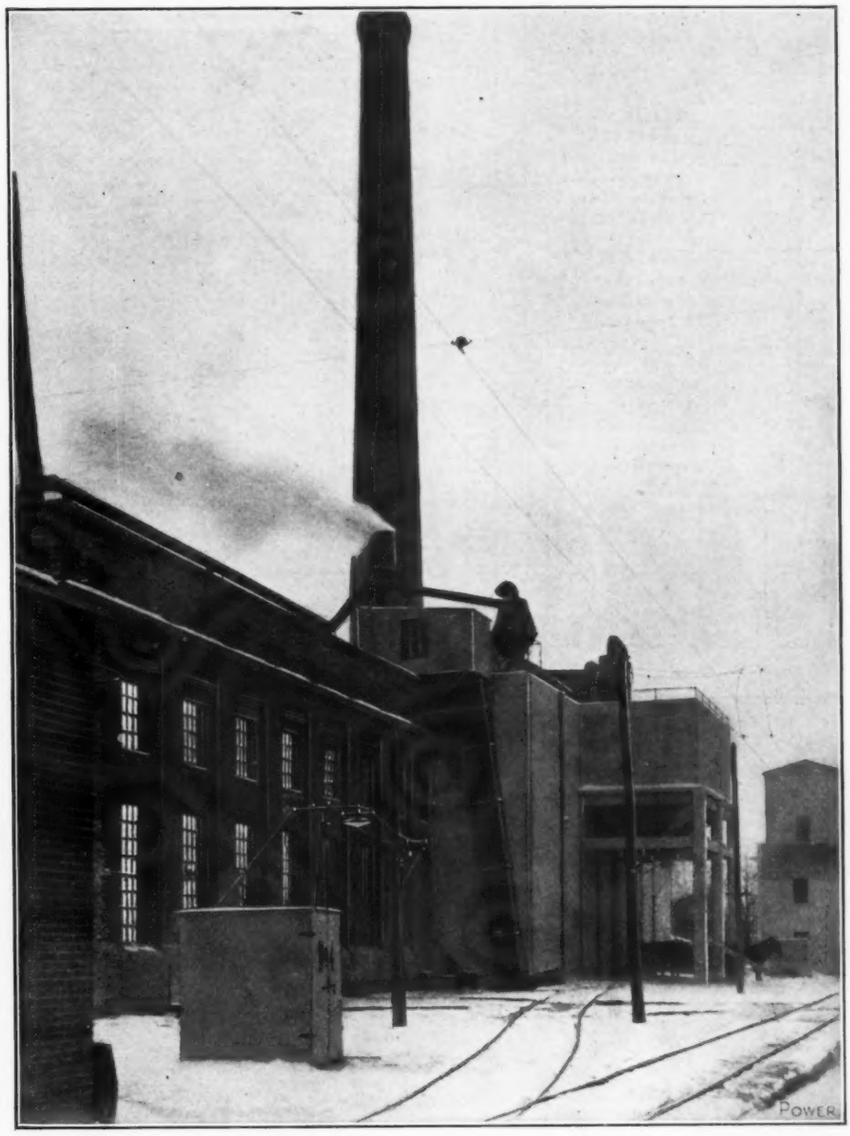


Fig. 4. Concrete Coal and Ash Bunkers, Showing Bucket Conveyor at the End

Ash Conveyor

The ashes are handled by an ash suction conveyor. The bottoms of the ashpits are about 3 ft. above the basement floor, the dividing wall in the basement forming the front wall. Each ashpit is provided with a double clean-out door,

as shown in Fig. 9. In front of each clean-out door a concrete ash hopper, 4 ft. long, 3 ft. 9 in. wide and 3 ft. high, has been constructed. In the center of each is an 8-in. opening which connects to an 8-in. ash pipe that runs to the two ash bunkers located at the top and at the back of the coal bunker. Their position is shown in Fig. 7. The

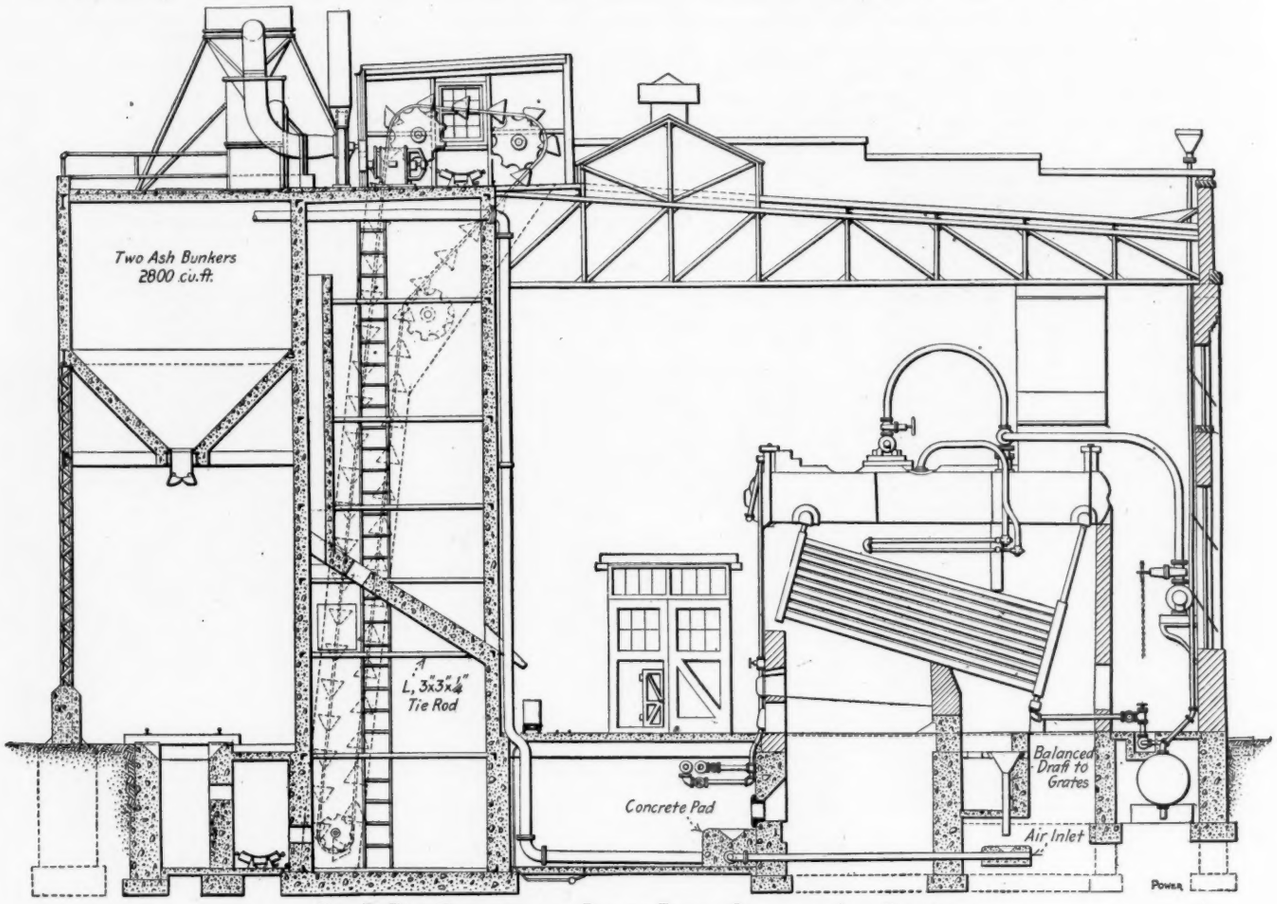


FIG. 7. END ELEVATION OF BOILER ROOM, COAL AND ASH BUNKERS

EQUIPMENT OF THE AEOLIAN POWER PLANT

No.	Equipment	Make	Use	Kw.	Volts	Amp.	R.p.m.	Size	Pressure, Lb.	Hp.	Manufacturers
1	Engine	Ballwood	Main unit	400			150	20x34x28	165		Ball-Wood Co.
3	Engines	Ames	Main units	75			275	14x14	165		Ames Iron Works
2	Engines	Vertical	Driving fan					9x7	165		American Blower Co.
1	D.-c. generator	Crocker-Wheeler	Main unit	400	250	1600	150				Crocker-Wheeler Co.
3	D.-c. generators	Westinghouse	Main units	75	250		275				Westinghouse Electric & Mfg. Co.
1	Volute pump	Watson-Stillman	Factory well				1525				Watson-Stillman Co.
1	Steam pump	Duplex	Factory supply					5½x4x5	165		Henry R. Worthington
1	Steam pump	Duplex, outside	Boiler feed					7½x5x6	165		Henry R. Worthington
1	Steam pump	Duplex outside	Boiler feed						165		Platt Iron Works
1	Duplex pump	Knowles	Fire					18x10x12	165		Blake & Knowles Steam Pump Works
2	Duplex pumps	Blake	Oil					No. 6			Blake & Knowles Steam Pump Works
1	Duplex pump	Knowles	Return system					8x10x12	165		Blake & Knowles Steam Pump Works
1	Steam pump	Duplex	Return system					8x12x12	165		
3	Steam boilers	Babcock & Wilcox	Steam generator						165	400	Babcock & Wilcox
3	Superheaters	Foster	Superheating steam								Power Specialty Co.
1	Air lift	Pohle	Deep well								Ingersoll-Rand Co.
1	Air compressor	Clayton	Well service					8x10x8	165		Clayton Air Compressor Works
1	Governor	Foster	Air compressor								Foster Engineering Co.
1	Heater	Open	Feed water					No. 4			Platt Iron Works
1	Filter	Richardson	Oil								Peterson Engineering Co.
3	Balanced draft	McLean	Boiler furnace								The Engineer Co.
1	Fan	Sirocco	Forced draft								American Blower Co.
1	Fan		Ash system								Guarantee Construction Co.
1	Motor	Westinghouse	Driving volute pump		250	288				7½	Watson-Stillman Co.
3	Motors	Direct current	Conveyors		220	39.5	700			10	Garwood Electric Co.
1	Motor	Direct current	Ash fan							30	General Electric Co.
2	Balancers	Crocker-Wheeler	3-wire system		125	30	1300				Crocker-Wheeler Co.
1	Controller	Sundh	Motor control								Sundh Electric Co.
3	Controllers	Cutler-Hammer	Conveyor motors								Cutler-Hammer Mfg. Co.
1	Regulator	Mason	Fan engines						165		Mason Regulator Co.
1	Conveyor	Bucket	Coal								The Jeffrey Mfg. Co.
1	Conveyor	Belt	Coal								The Jeffrey Mfg. Co.
1	Conveyor	Darley	Ash								Guarantee Construction Co.
1	Chimney	Custodis	Furnace gases					178 ft. high			Alfons Custodis Chimney Construction Co.
	Architects										Balch & Beardsley
	Consulting engineer										Otto G. Goldschmidt
	Chief engineer										J. A. Lane

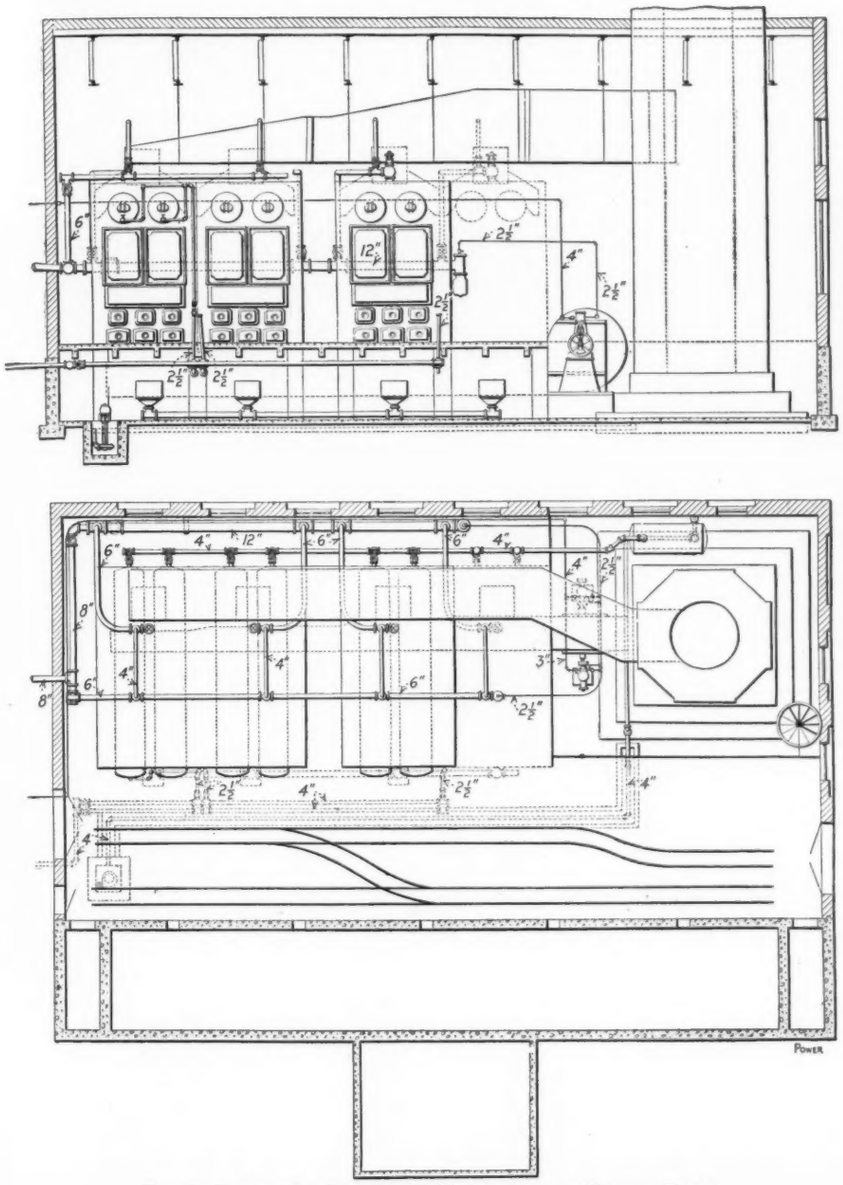


FIG. 8. PLAN AND SECTIONAL ELEVATION OF BOILER ROOM

ash bunkers have a capacity of 2800 cu.ft.

The sides of the concrete ash hopper slope toward the outlet opening, the top opening being 2 ft. 7½ in. wide by 2 ft. 9 in. long. At the side of the chimney, at the bottom, a clean-out door is provided so that the accumulation of fine ash can be hoed out into a 5-in. pipe which connects with the 8-in. suction pipe of the system.

In the roof monitor of the boiler room the fan and motor are located as shown in Fig. 7. The ashes are handled dry and are discharged into the ash bunker without coming in contact with the fan, which creates a suction in the ash pipe. The ash inlets are stoppered when not in use, but as soon as a cover is removed from an inlet opening a strong air blast draws the ashes and clinkers into the ash-storage tank.

Although the ashes are handled dry, they are wet upon entering the storage tank, where a water spray is used. The elbows of the ash pipe are made with detachable wearing plates at the turns. The ash bunker is supported by concrete piers and the ashes are dumped either into railway cars or into carts; one is shown in position for receiving a load in Fig. 4. The system of ash handling keeps the boiler room free from unnecessary dust and reduces the movable operating parts to the motor and fan.

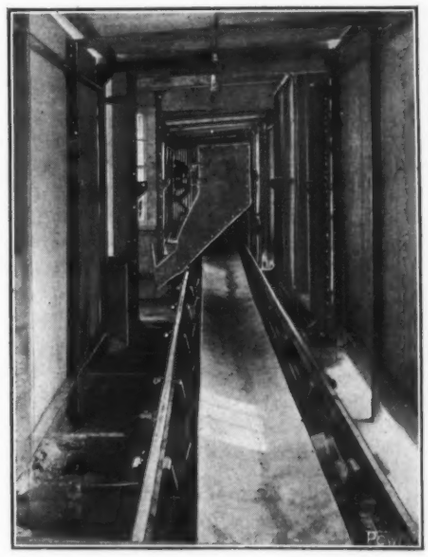


FIG. 6. SHOWING BELT CONVEYOR AND DISCHARGE CHUTE

The University of Pittsburg is entering upon a study of the smoke problem, taking as its chief lines of investigation the effect of smoke on health, plant life and buildings. It is also considering the increased cost of living due to damage and dirt caused by smoke, and both the legal and the engineering side of the question.

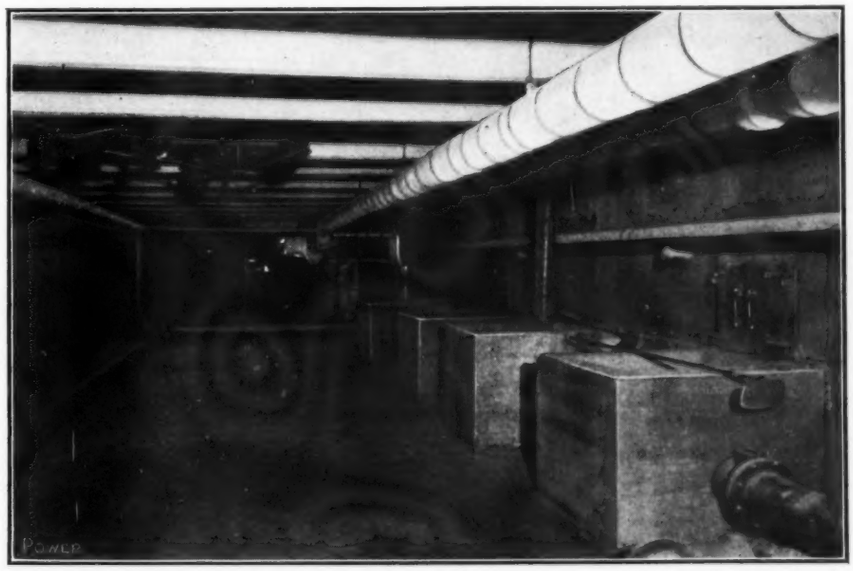


FIG. 9. CONCRETE ASH HOPPERS OF ASH-CONVEYING SYSTEM

Raising Water by Compressed Air

By Frank Richards

Theoretical horsepower required to raise water.

One convenient, though inefficient, way of raising water is to use air in an ordinary direct-acting steam pump. The losses occurring in such a case are pointed out.

One of the most obvious uses of compressed air is that of raising and conveying water and other liquids, and this has also become one of its most extensive fields of employment. The variety of ways in which the air is applied for this purpose and the diversity of the apparatus that has been devised are astonishing. While many have nothing more than a historic interest; the actual practical ways in which air now is employed for pumping, while differing widely from each other in efficiency and other particulars, are not numerous, yet they would be none the worse for still further elimination. The conditions under which the water is to be raised largely determine the specific device employed in the individual case, but sometimes other considerations not so defensible prevail in the selection or in the retention of deservedly obsolescent systems.

There is, according to the system adopted, much difference in the amount of air consumed as compared with the work done, but in all cases the former must be in excess of the theoretical requirement, as nothing can be done for nothing. With our present knowledge, it still pays in many cases to use air for raising water, in both small and large quantities, and as a means of permanent supply as well as in temporary or emergent cases.

It is desirable not only to do but also to know that we are doing the work as cheaply as possible. Our present facilities make the metering of water lifted or transferred an easy thing to do, and the raising of water, by compressed air or otherwise, can always be gaged with satisfactory accuracy, while records of such work are constantly accumulating and are accessible as guides to the engineer.

The theoretical horsepower required for raising water is

$$\frac{\textit{Pounds of water per min.} \times \textit{height of lift in ft}}{33{,}000}$$

The accompanying table may be taken as a starter; it furnishes the essential data as to the power required for raising water to different heights. It gives also the actual potential energy in the water so elevated, or the power which it should be theoretically possible for the water to develop in its descent to normal level if employed in a water-wheel or motor. When the power actually consumed in a water-raising operation is ascertained it can be compared with this table and the result will be an indication of the efficiency in the given example.

The first column gives the number of gallons of water lifted; column 2 gives the volume in cubic feet of the given number of gallons, while column 3 gives the weight in pounds of the same quantity of water. Column 4, assuming that the given quantity of water—gallons, cubic feet or pounds—is raised to a height of 100 ft. in a minute, gives the horsepower theoretically required for the lift, or the horsepower which should be developed by the descent of the water to its original level. Any other figures or quantities not in the table will be in direct proportion to those given.

Driving Steam Pumps with Air

First of all (as an example of "how not to do it") consider what it costs to drive an ordinary, direct-acting steam pump by compressed air. It is often so convenient to do this, in mines, tunnels, excavations for foundations and elsewhere, that it is done generally without counting the cost, either before or after.

The simplest case is where the steam or air and the water cylinders are of the same diameter, and have the same stroke. Here if there were no allowances to be made for clearance losses, leakages, power required to overcome friction and inertia, and if it had cost nothing to compress and transmit the air, all these and other things being those which pure theory is so apt to belittle or ignore—the volume of air at the balancing pressure would just equal the volume of water delivered and the efficiency would be 100 per cent.

The standards of efficiency called the possible efficiencies are really the impossible efficiencies. It is well known that they can never be attained, and very far from it in the present case. The air pressure must be enough in excess of the water pressure to overcome the frictional resistance of the machine itself and of the water in contact with the surfaces in its restricted flow through valves and passages, and to give and maintain sufficient impulse in the otherwise inert column. For all this it will be proper to allow an initial deficiency in the air power at the pump which will average not less than 20 per cent., and the 100 per cent. efficiency with which the author started is reduced to 80 per cent.

But if there is such a deficiency, the pump will not go. This is understood; and the several deficiencies are anticipated and provided for beforehand by furnishing air in sufficient volume and at an excess of pressure to overcome them.

To run a pump comfortably the working pressure of the motor fluid should be somewhat above the actual requirement, but it is not necessary to speak of that here as affecting the power consumption.

Next, the matter of cylinder clearance may be considered, which is interesting in the direct-acting steam pump at any time, and especially so when the pump is driven by air. Nothing need be said about clearance losses in the water cylinder, for practically there are none, as all the spaces may usually be assumed to be filled solidly with water, and if everything is in good order all of the actual travel of the water piston is represented by water delivered.

Enough clearance losses in the air cylinder may be found to satisfy for both. The direct-acting pump has no crank to bring the piston to a dead stop always at the same point at the end of the stroke, and, as at the same time it must be certain that the piston shall never strike the head, very large clearance is provided. The filling of this large clearance together with that of the unavoidable clearance spaces in the passages between the valves and the cylinder, entails another large excess of air over that theoretically required, or a deficiency of work done as compared with the air consumed of, say, another 20 per cent. This percentage of 80 being 16, 64 per cent. of the original 100 at this point is left.

There is a third great loss of efficiency when compressed air is used to drive a direct-acting steam pump because the air is used at full pressure and shows none of the advantages of being used expansively. If, instead of using the air at its highest pressure to fill the cylinder to the very end of the pumping stroke, it could have been used in a crank-and-flywheel pump, or in one of any other design in which the air could have been cut off at the proper point of the stroke, so that it would have been discharged at a pressure nearly that of the atmosphere, then the work done for the quantity of air used would have been, on the average, varying with the initial pressure of the air, say, 50 per cent. more than without the cutoff and expansion. That is, it could and would have done one-half more work, and the failure to do this amounts to another deficiency of one-third, or, say, 33 per cent. This percentage of 64 being 21, there is left only 43 per cent. of the original 100, and this diminution of efficiency is all realized after the air has arrived at the pump and without look-

ing to the losses which have accumulated previous to its arrival on the job.

Not to Be Charged to the Air

Now, the curious thing is that not one of the losses here mentioned, nor any portion of any of them, is in any way chargeable to compressed air. They all inhere in the apparatus and in the system by which the air is applied to the work of lifting the water.

One loss peculiar to steam and entirely absent with air is the loss by condensation, concerning which it is not necessary to present any figures. It is plain that the air should not be blamed for any of the losses of which it becomes the agent when driving the steam pump.

Thus far, the direct-acting pump alone and its deficiencies or those which it entails, have been considered. Of course, the pump has nothing to do with the friction losses in transmission from the compressor to the pump. For all such losses and for all possible leakages allow, say, 5 per cent., deducting which from the 43 per cent., found above, leaves 41 per cent., all the rest having disappeared after the air left the compressor. The transmission loss just allowed would be greater with steam, while some of the distances which air may be carried are prohibitive with steam.

While the cost of compressing the air used is not considered, attention might be called to the approximate figures for compressing free air to, say, 80 lb., gage. Assuming a steam-driven, reciprocating air compressor and both compressor and pump to run regularly under their respective rated loads, the power which is being developed in the steam cylinder may be taken as a starting point or the basis of efficiencies. First must be deducted a sufficient allowance for the friction of the entire machine and for the leakage and clearance and other air-cylinder losses, amounting altogether to an inefficiency of at least 20 per cent., leaving 80 per cent. Then in the compression of the air the excess of power required for the actual adiabatic compression, instead of the theoretical isothermal compression, will be 34 per cent. This percentage of 80 being 27, the surviving efficiency will be 53 per cent. This being the efficiency of the compressor and 41 per cent. the pump efficiency, the ultimate efficiency of the combination is 21.73 per cent.; that is, it will take about 5 hp. in the steam cylinder of the compressor to realize 1 hp. in the actual lifting and delivery of the water. Actual results are seldom any better, and often much worse, than this in practice.

At least one hint may be taken from these figures, which is that the loss is the least where the working air pressure is the lowest. In the case of the direct-acting pump the difference may be made in the relative capacities of the air (driving) and the water (driven) cylinders, and, in general, the larger the former is, the better. Thus, supposing the air to be used at 40 lb., gage, instead of 80, the excess of mean effective resistance in the air-compressing cylinder would be only 22 per cent. instead of 34, and the loss in the pump air cylinder through not using the air expansively, would be relatively the same so that there would be a saving at both ends.

[A second article will appear in an early issue in which two types of air-lift system will be described.—Editors.]

TABLE OF STATIC WATER POTENTIALS

1	2	3	4	1	2	3	4
Gal.	Volume, Cu.Ft.	Weight, Lb.	Potential Hp. in Water Raised 100 Ft.	Gal.	Volume, Cu.Ft.	Weight, Lb.	Potential Hp. in Water Raised 100 Ft.
1	0.13368	8.355	0.025303	200	26.736	1671	5.0606
2	0.26736	16.710	0.050606	250	33.420	2089	6.3257
3	0.40104	25.065	0.075909	300	40.104	2506	7.5909
4	0.53472	33.420	0.101212	350	46.788	2924	8.8560
5	0.66840	41.775	0.126515	400	53.472	3342	10.1212
6	0.80208	50.130	0.151818	450	60.156	3760	11.3863
7	0.93576	58.485	0.177121	500	66.840	4177	12.6515
7.48	1	62.5	0.18928	550	73.524	4595	13.9166
8	1.06944	66.840	0.202424	600	80.208	5013	15.1818
9	1.20312	75.195	0.227727	650	86.892	5431	16.4469
10	1.3368	83.55	0.25303	700	93.576	5848	17.7121
20	2.6736	167.10	0.50606	750	100.260	6266	18.9772
25	3.342	208.87	0.63257	800	106.944	6684	20.2424
50	6.684	417.75	1.26515	850	113.628	7102	21.5075
75	10.026	626.62	1.89771	900	120.312	7519	22.7727
100	13.368	835.50	2.5303	950	126.996	7937	24.0378
150	20.052	1253	3.7954	1000	133.680	8355	25.303

Idaho Power Co. to Develop Large Irrigation Tract

The Crane Falls Power & Irrigation Co., of Boise, Idaho, will soon install three large Westinghouse electric motors, aggregating 5645 hp., nine control switchboards and six 300-kw. self-cooled transformers to help irrigate the Gem irrigation tract, lying near the Snake River.

It is not believed that the company's pumping station, which is located on the Snake River, will be completed and ready to commence pumping until 1913.

Red Lead Joints

By A. L. Haas

The many jointing materials now advertised as being the best for the purpose have obscured the old reliable red-lead putty.

To make a first-class joint, the white lead used must be unadulterated. Only the properly corroded product of metallic lead bought under a written guarantee should be used. To test for its purity, place a weighed sample in a plumber's ladle and heat; the linseed oil (if putty) will then be driven off and the heating being continued, 85 per cent. of the original quantity should reduce into blue metallic lead. Barytes, a chalky substance, refuses to reduce and can be detected by color, appearance and weight from the quantity of lead oxide present in the ladle. If a sample known to be impure is reduced in a ladle against a sample of genuine white lead, the experience gained will safeguard the user against possible future fraud.

It is impossible to stock red lead ground in oil, which is putty, for the reason that it sets in bulk as hard as stone in less than a week; when wanted for paint purposes it is ground as required. This fact explains its peculiar suitability as a jointing material.

The genuine white lead and boiled linseed oil having been obtained, proceed to work up as much dry red lead as possible into the white-lead putty, moistening it with boiled oil while mixing. Its condition at the finish should be quite plastic and soft under the fingers.

Red lead should not be used for joints certain to be repeatedly broken; sheet packing is the best. Three or four days should be allowed for a red-lead joint to harden before admitting steam. As taking up on the nuts cannot be done with this type of joint, it must therefore be ruled out for hurry-up jobs.

Means must be provided to prevent the plastic putty being squeezed out between the flanges; stranded lamp cotton, spun yarn, etc., have all been used for this purpose, not to forget corrugated copper and brass gaskets and, what is probably the best of all, wire gauze.

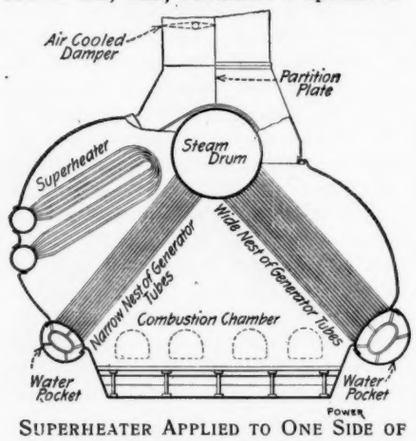
Where the face of the flange is pitted or rough, a wire-gauze joint interlaced with a couple of turns of lead wire and filled with red-lead putty, the completed joint being given time to harden, is a good remedy for a joint which proves repeatedly troublesome.

When it is clearly understood that a properly made red-lead joint lasts for the same length of time as the metal flanges, it proves that its choice has rested upon solid merit. Joints broken after 30 years of service without a leak show, when the castings have gone to the scrap heap, that the flange faces were like new metal and were as bright as the day they were machined.

A widely recommended joint cement having a secret formula proved to be litharge and adulterated white lead mixed, and contained a proportion of iron filings. It was used as a substitute to red lead when mixed with boiled oil. Its composition led to the belief that litharge might be profitably used as a good joint cement. Its ability to assist poor and adulterated paint to dry quickly points to its use where red lead might be inadmissible on account of the time required to harden it.

New Arrangement of Superheater with Yarrow Boiler

In a paper read before the Institution of Naval Architects on Mar. 28, Harold E. Yarrow, of the well known firm of Yarrow & Co., Ltd., described a special arrangement of superheater in connection with a Yarrow water-tube boiler.



SUPERHEATER APPLIED TO ONE SIDE OF YARROW BOILER

Formerly, the application of superheated steam to marine practice met with two objections: Owing to the dryness of the steam, oil for internal lubrication in reciprocating engines becomes a necessity and this oil, finding its way into the boilers, causes trouble. Again, there is danger of burning the superheater when the demand for steam is suddenly reduced.

The first of these objections has been overcome by the introduction of turbines into marine work and the arrangement described by Mr. Yarrow is intended to meet the second objection.

Referring to the illustration which represents a cross-section through the boiler, the superheater is shown placed over the left-hand nest of tubes. It will be observed that there are fewer rows of tubes on this side of the boiler, this being done so that the total heating surface and the resistance to the gases on both sides of the boiler would be practically the same. The total heating surface of the boiler was 6700 sq.ft., of which 1265 sq.ft. was superheating surface.

The superheater consisted of a number of U-tubes expanded into two longitudinal collectors, small doors being fitted so that access could be had to the tubes when necessary. A damper is placed in the uptake on the same side as the superheater and when this damper is closed, all the gases pass to the opposite side of the boiler. Thus if the main engines should be slowed down suddenly or stopped, or when raising steam, the superheater may be shut off by closing the damper and no damage will result to the tubes.

A further advantage of this arrangement is that when the demand for steam is suddenly reduced, not only does it prevent the tubes from overheating, but it also diminishes the output of the boiler at a time when a reduced supply is wanted, because only about one-half the heating surface comes in contact with the gases. To avoid the possibility of the damper becoming distorted through overheating, it is provided with a hollow spindle into which air is admitted, passing thence between the two plates of the damper.

In the evaporative tests referred to by Mr. Yarrow, oil fuel was used, one set of trials being made with the damper open and the other with the damper closed. The results of these are given in Tables 1 and 2 respectively.

Referring to Table 2, it will be seen that at the highest rates of evaporation nearly 2 lb. of oil were burned per square foot of heating surface per hour, disregarding the heating surface of the superheater side of the boiler. Thus the opposite side was subjected to the heating effect of all the gases plus half the radiated heat.

TABLE I. TRIALS WITH DAMPER OPEN

On these trials the heating surface was taken as the total heating surface of 6700 sq.ft.

Steam pressure, lb. per sq.in.	Superheat in deg. Fahr.	Air pressure, inches of water	Lb. of water evaporated per hour	Lb. of oil fuel per hour	From and at 212° Fahr.		Lb. of oil fuel per square foot of heating surface per hour	Temperature of feed water, deg. Fahr.	Temperature between small nest of generator tubes and superheater, deg. Fahr.	Temperature in Uptake, Deg. Fahr.	
					Lb. of water evaporated per lb. of oil per hour	Lb. of water evaporated per sq.ft. of heating surface per hour				Above superheater	Above large nest of generator tubes
242.0	93.5	5.0	94,659	8286	14.6	18.0	1.237	58.0	1121	828	887
243.0	93.0	3.16	76,021	6454	15.0	14.4	0.9635	63.5	926	698	727
243.7	82.5	2.44	68,387	5695	15.2	12.9	0.850	63.5	903	685	688
242.8	61.1	1.7	46,041	3630	15.9	8.6	0.542	64.0	647	536	551
241.8	31.0	0.998	20,059	1540	16.1	3.7	0.230	62.2	481	432	448
242.2	20.75	0.625	8,478	649	16.1	1.55	0.096	63.5	465	409	416

TABLE II. TRIALS WITH DAMPER SHUT

On these trials the heating surface was taken as the heating surface of the large nest of generator tubes = 3247 sq.ft.

Steam pressure, lb. per sq.in.	Air pressure, inches of water	Lb. of water evaporated per hour	Lb. of oil fuel per hour	From and at 212° Fahr.		Lb. of oil fuel per sq. ft. of heating surface per hour	Temperature of feed water, deg. Fahr.	Temperature of uptakes, deg. Fahr. above large nest of generator tubes
				Lb. of water evaporated per lb. of oil per hour	Lb. of water evaporated per sq. ft. of heating surface per hour			
242.0	4.85	68,648	6287	13.25	25.66	1.936	61.0	913
242.25	3.97	57,693	5065	13.84	21.6	1.56	60.0	843
242.4	2.491	44,050	3504	15.3	16.5	1.09	60.3	673
242.5	1.46	31,481	2473	15.4	11.75	0.76	63.5	603

Life Saving at Sea

The American Museum of Safety has announced that Judge Elbert H. Gary, on behalf of the United States Steel Corporation, has presented the museum with $5000 toward obtaining a collection of the best devices for saving life at sea, as a permanent exhibit for demonstration, free to the public.

Early next month, Director W. H. Tolman will attend the International Congress of Accident Prevention at Milan, and study the best European methods for life saving at sea, and the prevention of injurious effects of occupational diseases.

Arthur Williams succeeds Philip T. Dodge in the presidency. Mr. Dodge has withdrawn on account of ill health. President Williams announces another gift of $5000 from an "unknown friend" for research work in connection with industrial poisons.

The public is invited to visit the museum, at 29 West Thirty-ninth St., any day between 9 a.m. and 5 p.m., and inventors and others with practical ideas for life saving at sea are invited to submit them at the museum.

Home Made Hoists

By K. P. Everette

Realizing that the erecting work is often a large proportion of the total cost of small engines, a newly incorporated electric-light company thought it good policy to employ a chief engineer who would be as capable of installing the machinery as of operating it. Such a man was engaged and he immediately made all necessary preparations while the foundations were being built. The absence of overhead girders and the scarcity of blocking timber showed the necessity of some form of crane, so he constructed the acute-angled gallows frame shown in Fig. 1. The advantages of this form are obvious at first sight; it is self-contained, and is so supported and braced that it may be moved about while carrying its load centrally without danger of tipping over or spreading the legs. When such parts as connecting-rods are to be hoisted an overhang two-

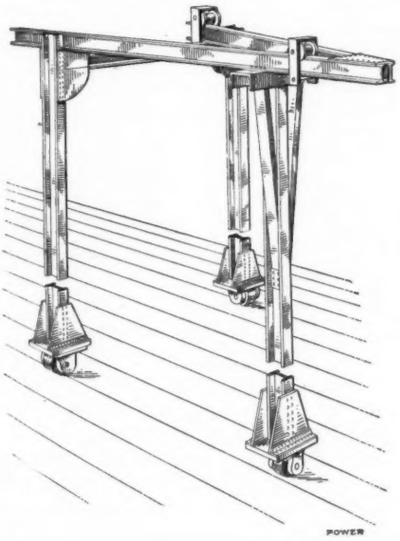


Fig. 1. Acute Angle Gallows Frame

bearing lift is obtained, and variations in the height of either end are easily secured by hoisting more on one block than on the other. When only one of the two travelers is needed, it can be placed at any convenient point; there are few spots around an engine or its auxiliaries over which some portion of the frame cannot be pushed. To move a heavy weight borne forward by both travelers away from the vertex of the angle, slings and spreaders are needed to cause the weight to descend slightly instead of rising. Its chief disadvantage is that when hoisting at any point beyond the center of gravity of the frame the opposite end must be weighted down to balance the load. The illustration amply shows the method of construction.

In a certain power station the condenser tubes require frequent renewal of packing; therefore the heads have to be removed. To facilitate this a 12-ft. piece of rail was secured on top as a track for a traveling head as shown in Fig. 2. The cover can be turned around, allowing the replacing of tubes, and by turning the bolt *A* it can be hoisted a

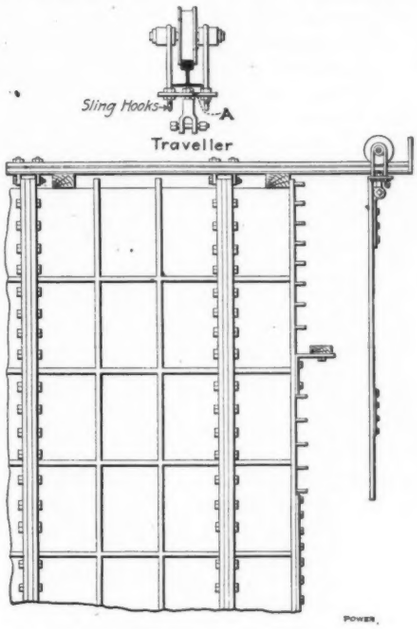


Fig. 2. Traveler and Track

trifle to clear the studs. A cheap and quickly made temporary derrick is shown in Fig. 3. Its capacity depends on the size and quality of the timber used, and the method of weighing down or otherwise securing the heel. A modification of this bearing a small flywheel is shown

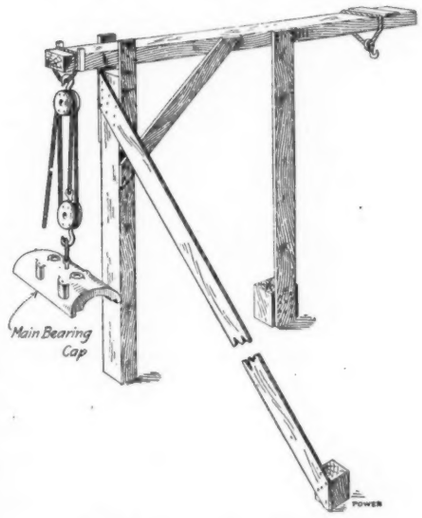


Fig. 3. Improvised Derrick

in Fig. 4. If the ceiling cannot be used to brace against, the beams may be secured by rope to the floor below, though this method would require more bracing lumber not heavier than 2-in. stuff.

The center of the wheel can be tilted either way to bring it square with the shaft. This is also a good form of rigging for placing the crankshaft of a center-crank engine in position to babbitt

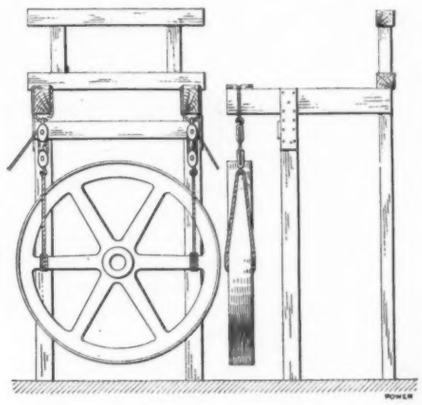


Fig. 4. Modification of Fig. 3

its main bearings. In one boiler room the furnace ashes had to be carried out through the engine room, a most inconvenient and dusty arrangement. To overcome this the engineer cut a large opening in the partition between the boiler

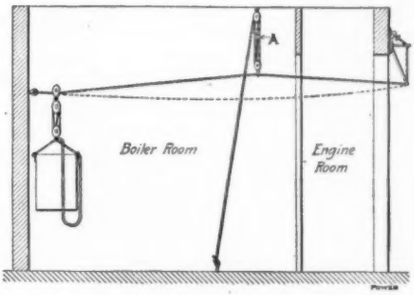


Fig. 5. Ash Conveyor

and engine rooms and then slung a slack 1¼-in. rope between the two opposite walls. A little beyond the middle of the rope a pair of small tackle blocks were secured as shown in Fig. 5. The manner of operation is apparent if it is supposed that the ash can is about to start on its journey, which is done by lowering on the central tackle *A*. When the block is reached it takes only a moment to change the hook to the other side of the load and hoist again, thus causing the ash can to continue its slide right out through the opened door.

Draft in the Boiler

By Everard Brown

The use of the word draft when applied to steam boilers is often misleading in that it may be applied to the motion of the gases through the boiler or it may mean the difference in the pressure producing this motion. Assuming the latter definition as correct, the greater the pressure difference the higher will be the velocity of flow because the motion is produced by an excess of pres-

sure at any given point over that at any other point toward which the flow is directed. This difference of pressure may be produced by chimneys, by exhausting fans or jets between the boilers and chimney and by pressure fans supplying air under the grate.

Of these methods the use of chimneys is the most prevalent and is commonly called the natural-draft system. Its popularity is due mostly to the fact that there is practically no expense connected with its operation. The performance of a chimney, however, is affected both by weather conditions and by the temperature of the escaping gases. This is due to the principle of its operation, which is simply to reduce the pressure within its base so that the greater atmospheric pressure without pushes air through the fuel bed and the gases of combustion through the boilers into the stack. The whole operation rests upon the expansion of the gases by heat, in consequence of which the weight of the gases in the chimney is less than if they were cold. It follows that the hotter the gases or the higher the chimney, the greater will be the difference in pressure.

The second method, that of installing an exhaust fan between the boiler and the chimney, is called the induced system, probably because the idea prevails that it draws the gases through the fuel bed and boiler. In reality, however, the fan simply forces the gases out of the casing and thereby reduces the pressure in it below that in the boiler, so that this excess pressure pushes other gas through into the space of reduced pressure, and so on. The use of an exhaust fan eliminates any necessity for a stack except as a means of carrying off the objectionable gases and its height may be governed accordingly.

The system is objected to by some operators on the ground that it causes excess air to rush into the furnace above the fire through leaks that might be in the setting or through the furnace doors. Such leaks in the setting, however, are always more or less injurious to economy and should not exist. The introduction of the induced draft in addition to that of the chimney may be made, for example, in old plants where an increase in the load or a different kind of fuel requires more draft than is available with the stack.

The third method, commonly called the forced-draft system, is to force air into the space under the grate and through the fuel bed, thus increasing the pressure therein above that of the surrounding atmosphere. With this system, as with the previous one, a high stack is not necessary except to carry the gases sufficiently high to be unobjectionable. Occasionally this and the induced-draft system are used together, as, for instance, with economizers. Forced draft, perhaps, has the advantage in that the amount of air going into the furnace can be regulated to suit the rate of combustion irrespective of weather conditions or gas temperatures, which is not the case with chimneys, and for this reason very little smoke is emitted from stacks where it is in use. It is always used with underfeed stokers.

The stronger the current of air through the fuel bed the higher, naturally, is the rate of combustion; also, the absorption of heat by the boiler increases with the strength of the current of gases passing over the heating surfaces. It is possible, therefore, to increase the working rate of the boiler in this way, although there are certain limits beyond which one cannot go because any advantages derived will be equaled or exceeded by the increased cost of operation. It would seem quite probable, however, that in some instances, the capacity of a plant could be doubled without necessitating any radical changes in the furnace or boiler.

Capacity does not depend altogether upon a great pressure drop through the fuel bed, but upon the difference between the pressures in the uptake and over the fire. Therefore, with a constant total draft, the boiler capacity varies inversely as the pressure drop through the fuel bed. In fact, a large drop through the bed usually indicates a high resistance to the flow of air and, consequently, a low rate of combustion.

Steam Consumption Per Horsepower Hour

By F. B. W. Barker

While most engineers are familiar with the use of the indicator and can use it intelligently in setting the valves and as an aid in obtaining the best economical operation of an engine, surprisingly few are familiar with the method of determining accurately the steam consumption of an engine or turbine per indicated or brake horsepower-hour.

For accurate engine tests surface condensers are employed, because the steam used by the engine is condensed and can be weighed or measured and the steam consumption determined directly. If the engine is operating with a vacuum, the condensed steam is removed from the condenser by the air pump, and when the engine is to be tested with the pressure in the condenser at atmosphere, the condensed steam can be removed by gravity.

The condensed steam is usually weighed in suitable tanks placed on accurate platform scales, but when very large quantities are to be measured the orifice method is the better. In this case the area of the orifice and the average head of the water must be accurately known and the discharge through the orifice calibrated under operating conditions.

As it is important that the condenser should be tight, it should be tested both before and after the test is made. If the engine is operating with a vacuum the same vacuum should be maintained in the condenser when it is tested for leaks. To test the condenser pass the condensing water through the tubes at its normal rate of flow, and note the amount of water, if any, collected in the steam space during a given time.

Another method would be to close all the openings to the steam area of the condenser and ascertain whether a vacuum can be maintained for a reasonable length of time. If salt water is used as a condensing medium, a solution of nitrate of silver can be added to a sample of the condensed steam and if no considerable cloudy precipitate of silver chloride appears, the condenser can be considered tight.

When a plant is operating noncondensing, or when condensing, and using a condenser in which the steam and condensing water mingle and the cost of installing a surface condenser would not be feasible, the steam used by the engine or turbine can be determined by the weight of the feed water entering the boilers, if they supply nothing but the engine under test.

This condition rarely exists, but in most plants having several boilers the steam piping can be so arranged as to disconnect one or more boilers from the battery, and supply only the engine.

Care must be taken that all the water entering the boiler is converted into steam and passes through the engine. All leakage in the boilers and piping should be stopped and the principal source of loss, the boiler blowoff connections, should be blanked. The quality of the steam should be determined at regular intervals, and the engine under test credited with the moisture which it contains. Still another method of obtaining the steam consumption of an engine having a barometric or similar condenser, in which the steam mingles with the condensing water and is discharged with it from the apparatus, is by the measurement of the amount of heat transferred from the steam to the condensing water.

The objection to this method is its unreliability, owing to the difficulty in obtaining the correct average temperature of a large volume of water flowing through a pipe.

The load on the engine should always be kept uniform throughout the test. It can be determined at regular intervals, with the indicator or prony brake, depending upon whether the steam consumption per indicated or brake horsepower-hour is desired.

By approaching his men in the right way, even the chief engineer occasionally picks up a valuable operating hint or improvement.

Kinetic Theory of Gases and Steam

By W. H. Booth

The pressure exerted by a gas inclosed in a vessel is considered as due to a continual bombardment of the walls of the the vessel by the molecules of the gas.

The action of steam in a condenser and in an engine cylinder is explained.

According to the kinetic theory, a gas consists of a great number of infinitely small molecules, each of which is endowed by its heat contents with mobility. Small as they are, these molecules have a certain mass, and the number of them in a cubic inch of steam has been calculated, as has also their mean free path or the distance they can travel without bumping against one another.

If a pump is set to draw out the contents of a closed vessel containing a gas, the time may be imagined when only one molecule remains. If this were visible, it could be seen to be darting about at a high velocity striking every wall of the vessel. By the kinetic theory the pressure of a gas is due simply to the impact of the gaseous molecules. It is said that a gas presses equally on every portion of its containing envelope. Substantially this is true, but it is not absolutely true, for the very nearly perfect vacuum of one molecule in a vessel, say of cubic shape and therefore possessed of six sides, cannot represent equality, all the pressure effect is concentrated on one of the six walls, and five walls are absolutely free of pressure.

No vacuum has yet been pumped so perfect as not to contain millions of molecules per cubic inch, and with such a number there is always practically an equality of pressure on every bounding wall, but one cannot be assured that the pressure actually and absolutely is equal on all sides.

As with all moving bodies, the gaseous molecules move in straight lines until deflected by collisions and by gravity. Gravity gives an additional velocity to the downward moving molecule and retards those which are moving upward; this accounts for the fact that gas pressure is greater at the bottom of a vessel than at the top. Thus in an air reservoir 10 ft. high, the pressure is higher at the base by about 0.005 lb. per square inch representing the increased impact due to a fall of 10 ft.

In a vessel containing a gas not all the molecules hit the sides, those next to the wall rebound and at once strike other molecules and bound back to the wall repeatedly. But the effect is the same, and the final result is that if there are two or more different gases in one vessel they will diffuse and form a mixture.

If a molecule hits a moving body it adds to the velocity of that body and bounds back itself at a speed less than it possessed previously. Thus the steam molecules in a cylinder may be imagined as bounding to and fro between the cylinder end and the piston face. They strike these two faces many hundred times per second for each molecule, and at each rebound from the moving piston they lose velocity; and since their temperature is due entirely to their velocity they are rendered colder. Thus it is evident why expanding steam in a cylinder is cooled and also why steam expanded into a fixed space is not cooled but superheated, for, the walls, not moving away from the molecules, cause the latter to rebound with their striking velocity and, therefore, do not lose heat, but if the walls are cold they absorb heat and the steam is thus made to move more slowly.

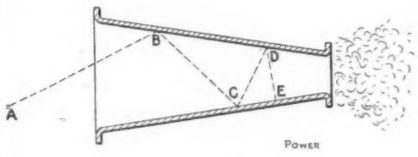


FIG. 1. CONVERGENT NOZZLE, WITH NO DEFINITE PATH FOR EXIT GASES

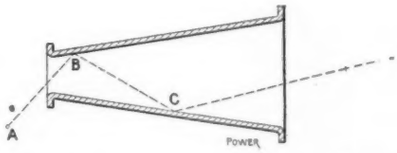


FIG. 2. DIVERGENT NOZZLE FROM WHICH GAS ISSUES IN A STRAIGHT PATH

There are many things one can learn from this kinetic theory. It is known that water-hammer is due to steam driving plugs of water along pipes toward portions of the pipes. Also, a body acted upon by an external force will increase in velocity to an infinite extent. This will apply to such a force as gravity which adds velocity at the rate of 32.16 ft. per sec. every second.

Now, this reasoning cannot be applied to steam and water-hammer. A plug of water 1 in. in cross-section and 30 lb. in weight will gain in velocity 32.16 ft. per sec. for each second it is urged by steam of 30 lb. pressure. But this is only true just at the start, for each second the force acts, the water moves more nearly at a velocity equal to that of the steam. When the water is moving at the molecular velocity of the steam it cannot move faster, for it would leave the steam behind. Hence, the velocity of water-hammer is thus limited to the molecular velocity of the driving steam.

Many marvel at the very slight movement of the vacuum gage when a large cylinder suddenly exhausts into a cold condenser. The pointer swings through a very small arc and promptly returns again, indicating that all the steam molecules found a cold surface. Since their velocity may be as high as 1800 ft. per sec., no molecule in a condenser of 18 cu.ft. could require more than 0.01 sec. before it reached a cold surface. The average time would be more nearly 0.005 sec. A poor vacuum in a condenser is due to the noncondensible gases being carried with the rush of steam upon the cold surfaces, which they blanket off from subsequent steam. Or if the cold surfaces get so much heat from the molecules of steam that they become heated, the steam molecules continue to bound back from them and produce back pressure.

One of the errors in condensing practice has been to place directly across the path of the steam a small fraction of the cold surface so as to form an almost continued wall of the first two rows of tubes. Now, however, it is more usual to leave gaps in the nests of tubes so as to insure a free path to the cold surface behind the first row of tubes, and so on.

One is apt to consider that all fluids are subject to the same influences with similar results, but there are distinct differences between elastic and inelastic fluids. Take, for example, the production of a smooth, easily flowing parallel jet of water issuing from a vessel, through a wide orifice contracted by easy curvature to a parallel end. The jet of a Pelton wheel is an example in point. But if a gas is made to issue through such an orifice it will spread out at the narrow end of the nozzle.

This effect is well shown in many liquid fuel burners which give a wide-spreading flame. The reason for the different behavior of water and of gas is that the water molecules are very much less active and are simply propelled by pressure from behind; the gas molecules are all free and very active. When they strike a surface they rebound at the angle of impact. Thus in Fig. 1 a molecule *A* follows the dotted line and makes equal angles at *B*, equal angles at *C* and equal angles at *D*. It arrives at *E*

and then strikes at an angle of 90 deg. and rebounds along its line of arrival, and if it were a lonely molecule it would simply retrace its path to *A*. This tendency explains the choking effect of such a convergent nozzle and the spreading out at the mouth of such molecules as get to that point with a movement transverse to the axis of the nozzle.

Now consider a diverging nozzle, as in Fig. 2, and start a molecule at *A;* it will strike *B* and *C,* making equal angles, and it is obvious that if the nozzle were only longer the rebound from the next impact *D* would be parallel with the axis of the nozzle. This tendency to parallelism belongs to every molecule and the jet no longer spreads out. Such jets are used in the De Laval and similar steam turbines and produce a maximum effect, for no molecules waste their energy by traverse movement or lateral expansion.

Of late, certain men have denied the existence of cylinder condensation as taught by Hirn. A small amount of condensation is admitted, but the greater part of the loss is attributed to valve leakage. Those who believe in Hirn's teaching cannot discover any proof of the more recent theory in any of the test figures put forward. The latter theorists practically deny the "kinetic theory" of gases for they speak of the impossibility of condensation occurring in so brief a space of time as in the stroke of a fast running engine. But an engine running at 600 strokes per minute occupies one-tenth of a second per stroke and every molecule of steam in the cylinder could travel about 200 ft. in the time of one stroke or, say, 30 or 40 ft. during the admission period. Such a velocity is ample for all the molecules to reach the cold walls.

The kinetic theory in thermodynamics is like the atomic theory in chemistry—a useful aid to the understanding of phenomena. Some people now deny the atomic theory, but it has long sufficed to carry chemistry along the right road. Indeed, in regard to the moving of a piston and to the effect on the steam thus produced by doing work, the kinetic theory affords a clearer insight to the whole mechanical and physical action than any other explanation or theory.

Bureau of Mines' New Publications

The following publications can be had on application to the director of the Bureau of Mines, Washington, D. C., if ordered by number and title:

Bulletin 10, "Use of Permissible Explosives," Clarence Hall and J. J. Rutledge; 34 pp. No. 23, "Steaming Tests of Coals and Related Investigations, Sept. 1, 1904, to Dec. 31, 1908," L. P. Breckinridge, Henry Kreisinger and W. T. Ray; 380 pp.

Technical Paper No. 8, "Methods of Analyzing Coal and Coke," F. M. Stanton and A. C. Fieldner; 21 pp. No. 10, "Liquefied Products from Natural Gas; Their Properties and Uses," I. C. Allen and G. A. Burrell; 23 pp. No. 11, "The Use of Birds and Mice for Detecting Carbon Monoxide After Mine Explosions and Fires," G. A. Burrell; 14 pp.

Reprint—Bulletin 34, "Tests of Run-of Mine and Briquetted Coal in a Locomotive Boiler," W. T. Ray and Henry Kreisinger; 32 pp.

Loss by Throttling a Turbine

A correspondent asks: "What is the loss in efficiency due to a drop of 10 pounds at full load across the throttle of a 4000-kilowatt turbine, the pressure at the throttle being 150 pounds, the superheat 100 degrees and the vacuum 28 inches?" The steam consumption under the above conditions is 16.6 pounds per kilowatt-hour. He would also like to know the gain in capacity due to eliminating this drop, if that were possible.

The energy generated by the drop of 10 pounds goes at first into accelerating the velocity of the steam through the constricted opening of the throttle. If the velocity in the pipe or chamber on the turbine side of the throttle is the same as that in the pipe upon the boiler side—that is, if the velocity after throttling is the same as before—the energy represented by the higher velocity in the throttling passage will be reconverted to heat when that velocity is destroyed and the throttled steam will have just as many heat units per pound as it had before it was throttled, but a smaller number of them will be convertible into mechanical energy because the initial "head" has been reduced.

The rule for finding the energy generated by expanding steam from one pressure and quality to another is

*From the total entropy of the steam in the first condition subtract the entropy of the water in the second condition. Multiply the difference by the absolute temperature in the second condition, and subtract the product from the difference between the total heat in the first condition and the heat of the liquid in the second condition.**

The Marks-Davis tables for superheated steam give the total heat per pound of steam at 165 pounds absolute and 100 degrees superheat as 1232 B.t.u. and the entropy as 1.6269. At 155 pounds the entropy for the same total heat would be, by interpolation from the same table, 1.6333. The temperature, corresponding to 28 inches of vacuum, is 100 degrees Fahrenheit and the heat of the liquid at that temperature is 67.97 B.t.u.

All of these values can be gotten from the steam table. Performing the arithmetical operations indicated by the rule we have for the first condition:

165 pounds and 100 degrees superheat

$N_1 = 1.6929$ $t_2 = 100$ $1252.00 = H_1$ $67.97 = h_2$

$n_2 = 0.1295$ 460 $1184.03 = H_1 - h_2$

$N_1 - n_2 = 1.4974 \times 560 = 838.54 = (N_1 - n_2)\,T$

345.49 B.t.u. convertible into mechanical energy.

For the second condition

155 pounds throttled from 165

$N_1 = 1.6333$
$n_2 = 0.1295$ 1184.03

$N_1 - n_2 = 1.5038 \times 560 = 842.13$

341.9 B.t.u. convertible into mechanical energy.

This is the number of B.t.u. which a perfect engine could convert into mechanical energy working between the given limits. The falling off for the second condition is

$$\frac{345.49 - 341.90}{345.49} = 0.01 \text{ or } 1\%$$

This accords with the results of practice where turbines which do not govern by throttling, so that the full initial pressure is available, give an increased efficiency of about 0.1 per cent. for each pound of additional initial pressure.

As to the effect upon capacity, the amount of steam flowing through the first set of nozzles or guide vanes will be roughly proportional to the absolute initial pressure. The turbine, for example, with all the nozzles open or with the admission valve full open all the time would take $\frac{165}{155} = 1.065$ times as much steam with an initial pressure of 165 pounds as of 155 pounds absolute. With equal efficiency it would do 1.065 times as much work (6.5 per cent. more) with the higher initial pressure. If the efficiency is 1 per cent. better it will be

$$1.065 \times 1.01 = 1.076$$

times as much work, or 7.6 per cent. more.

Acting on data furnished by field men, the United States Geological Survey took action in March leading to the creation of water-power-site reserves in Arizona, Colorado, New Mexico, Utah and Washington aggregating 24,091 acres. The reservations are believed to contain many favorable power sites. Restorations of more than 10,000 acres of land previously withdrawn in connection with power sites were made during the month in Colorado, Idaho and Washington. This land was found upon further investigation to be not necessary to the control of power sites.

*$H_1 - h_2 - (N_1 - n_2)\,T_2$.

Where
H_1 = Total heat per pound in initial condition;
h_2 = Heat of liquid in final condition;
N_1 = Total entropy in initial condition;
n_2 = Entropy of liquid in final condition;
T_2 = Absolute final temperature (F.° + 460).

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Transformer Connections

By Cecil P. Poole

Since no skill is required in the connection of three-phase transformers to the primary and secondary circuits and there are no two-phase transformers, the present article is confined to the connections of single-phase transformers on two-phase and three-phase circuits.

Two-phase Connections

Practically all two-phase lines are merely two single-phase lines supplied from the same source with currents which are out of step with each other to the extent of one-quarter of a cycle, or 90 electrical "degrees." For the delivery of current to lamps and other devices except two-phase motors, transformers are connected to the two lines exactly as they would be to two separate single-phase lines not related to each other, with the exception that the amount of load connected to the two station lines should be divided equally between them, as nearly as possible.

Fig. 1 shows a simple two-phase primary circuit with transformers connected to it and supplying individual secondary circuits, which are single-phase, of course. One of the transformers is represented by the conventional diagram indicating its primary and secondary windings.

Transformers can be "banked" on one of the divisions of a two-phase line exactly as in the case of a single-phase circuit. The same precautions as to instantaneous polarities, equality of size, similarity of type, etc., that were described in the explanation of single-phase work apply to two-phase connections and the same objections exist.

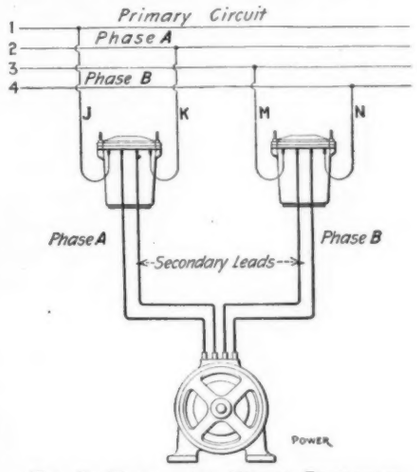


Fig. 2. Two-phase Motor Properly Connected

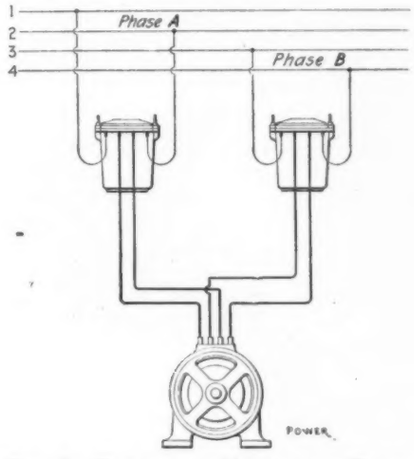


Fig. 3. Two-phase Motor and Transformers Connected with "Mixed" Secondary Leads

When a two-phase motor is to be supplied through transformers, two transformers exactly alike are used and these are connected up as shown in Fig. 2. It makes no difference, so far as the effect on the transformers is concerned, which way the leads are connected to the circuits. The leads *J* and *K* may be transposed without causing any trouble in the transformers; this is true also of the leads *M* and *N* and of each pair of secondary leads.

The transposition of any pair of leads, however, will reverse the direction in which the motor runs. For example,

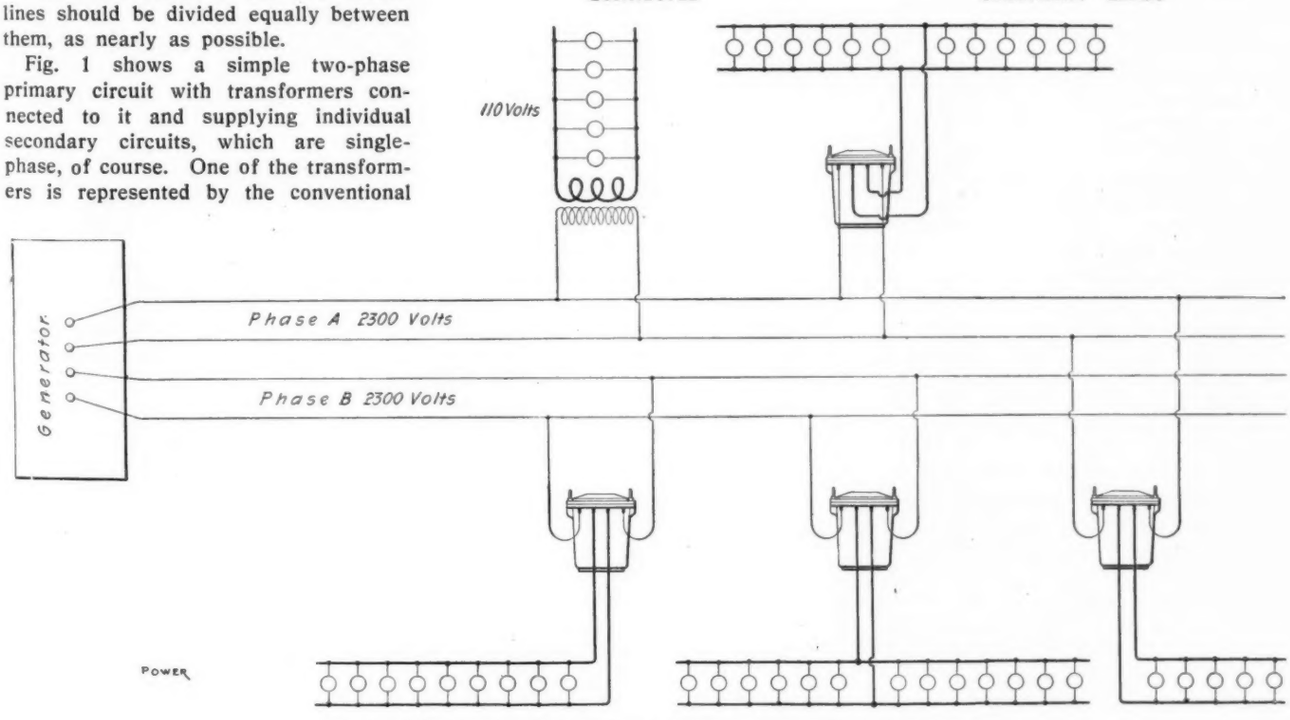


Fig. 1. A Balanced Two-phase Circuit Supplying Lamps Only

if the motor shaft turns clockwise with the connections as indicated in the diagram, transposing the wires of any pair, such as connecting *J* to the primary wire 2 and *K* to the wire 1, will cause the motor to run counterclockwise. If two pairs of leads be transposed, the direction of rotation will remain as before, because one transposition would reverse the motor and the second transposition would re-reverse it back to the original direction.

In connecting up the transformers of a two-phase motor care must be observed to put one transformer on one primary phase and the other transformer on the other phase. The same precaution must be observed in connecting the secondary leads to the motor. If the transformers should be connected up

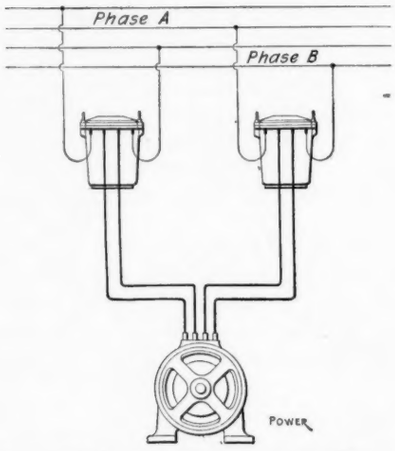


FIG. 4. TWO-PHASE MOTOR AND TRANSFORMERS CONNECTED WITH "MIXED" PRIMARY LEADS

with mixed phases, at either the primary or the secondary leads, the motor will not run. Fig. 3 shows mixed secondary phases; one lead from the "A" transformer is connected to one of the "A" terminals of the motor and the other lead to one of the "B" terminals, and the leads from the "B" transformer are similarly mixed. Fig. 4 shows mixed primary phases; each transformer is connected to both phases of the supply

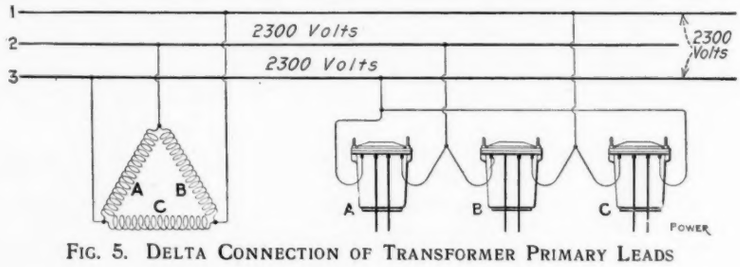


FIG. 5. DELTA CONNECTION OF TRANSFORMER PRIMARY LEADS

circuit and neither one gets the proper current for operating the motor.

It is practical to use any of the connections on either division of a two-phase system that can be used on a single-phase system, but it is seldom desirable to use any other than the simple straightforward connections shown in Figs. 1 and 2.

THREE-PHASE CONNECTIONS

There are two general plans of connecting transformers on a three-phase system: "delta" and "star." The delta connection is represented by the diagrams in Fig. 5, where the primary windings are shown at the left and the corresponding transformer arrangement and circuit connections at the right. Although this arrangement appears on paper as though the transformer windings were short-circuited, that is not true if they are properly connected, because the phase differences and momentary polarities of the electromotive forces prevent it. When the voltages of any two of the windings are in the same direction around the triangle, the voltage of the third one is opposed to them and equal to both of them added together.

The star connection is represented in Fig. 6. Only one terminal of each transformer is connected to the circuit; the other three are connected together, and this connection is called the "neutral" point of the system.

With the delta connection, the voltage

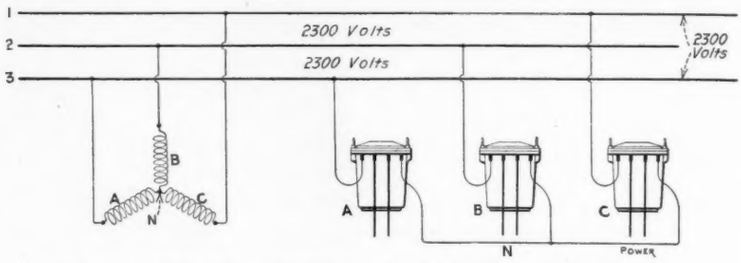


FIG. 6. STAR CONNECTION OF TRANSFORMER PRIMARY LEADS

of each transformer is that of the circuit; in Fig. 5, for example, each transformer receives 2300 volts from the primary circuit. With star-connected windings, however, each transformer receives at its primary terminals only 57.7

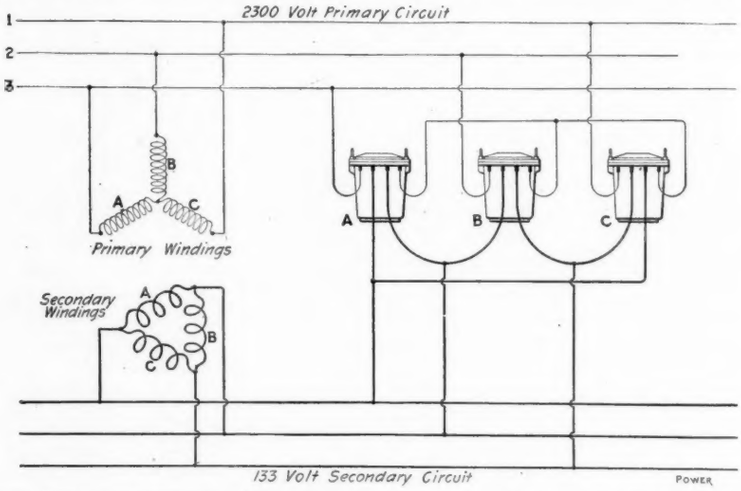


FIG. 7. DELTA-CONNECTED PRIMARY LEADS AND STAR-CONNECTED SECONDARIES; TERMINAL VOLTAGE RATIO = 57.7 × RATIO OF WINDINGS

per cent. of the circuit voltage. For example, if the voltage between any two of the primary wires is 2300, as indicated in Fig. 6, the e.m.f. at the terminals of each transformer winding will be 1327 volts.

This peculiarity of three-phase star connections—the voltage between each main and the neutral being 57.7 per cent. of the main-to-main voltage—can be made useful in some cases where two voltages are required and in others where changes in the transformer ratio are desirable. Since the same rule applies to the secondary windings, three voltage combinations are possible by merely changing the connections of the primary and secondary leads, no "taps" in the windings being necessary.

Fig. 7 shows three transformers connected to give minimum secondary voltage. The ratio of the transformer *windings* is 10 to 1; that is, the secondary

voltage of each transformer is one-tenth of the primary voltage applied to its terminals. With 2300 volts between each pair of wires of the primary circuit, the primary voltage of each transformer is 1327; this makes the secondary voltage 132.7, and as the secondaries are delta-connected in Fig. 7, this is the voltage in the secondary circuit to the motor.

In Fig. 8, both primary and secondary windings are star-connected; consequently, the *transformer* primary voltage is 57.7 per cent. of the primary *circuit* voltage, or 1327 volts, and the secondary voltage of each transformer (132.7) is 57.7 per cent. of the secondary circuit voltage, which is therefore 230 volts.

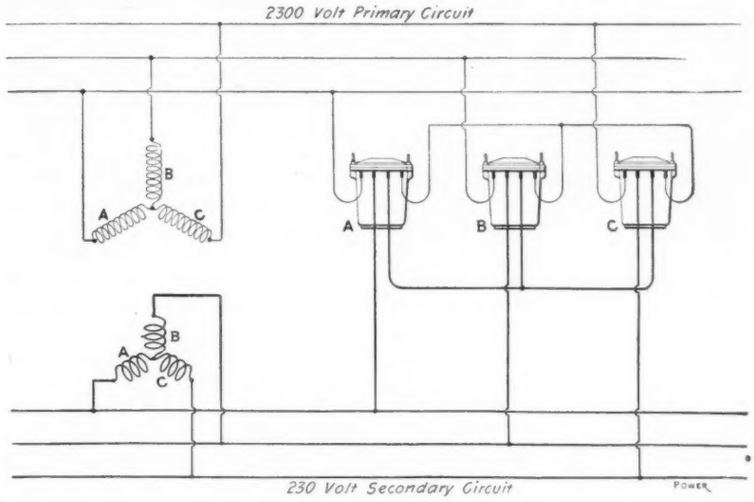


FIG. 8. PRIMARY AND SECONDARY LEADS BOTH STAR-CONNECTED; TERMINAL VOLTAGE RATIO = RATIO OF WINDINGS

Fig. 9 shows the final combination, delta-connected primaries and star-connected secondaries. The primary transformer voltage is 2300 and the secondary transformer voltage 230, but the star connection makes the secondary *circuit* e.m.f. 1.732 × 230 = 398 volts.

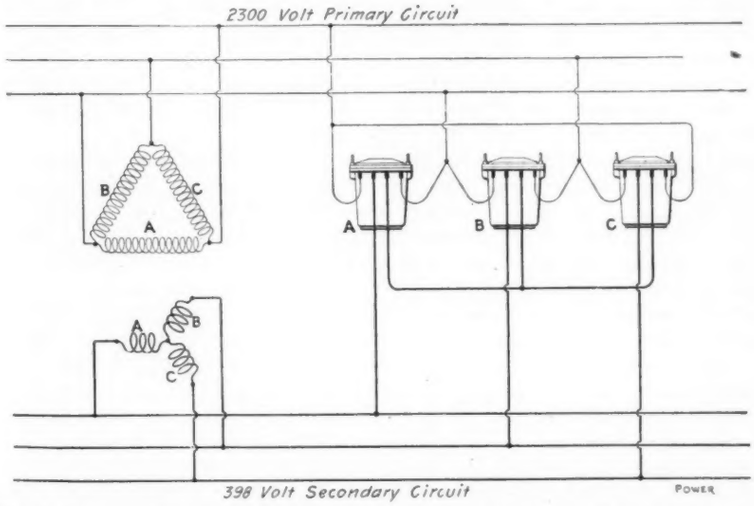


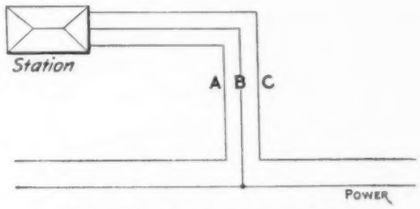
FIG. 9. PRIMARY LEADS DELTA-CONNECTED AND SECONDARIES STAR-CONNECTED; TERMINAL VOLTAGE RATIO = 1.732 × RATIO OF WINDINGS

The full number of combinations just described is seldom, if ever, used in power-plant practice; it entails the disadvantage of carrying both the primary and secondary leads of the transformers through a controlling switch, and this would cause more trouble and danger than the resulting advantage is worth, outside of a laboratory or a test room. The secondary connections, however, are sometimes arranged to be changed from delta to star by means of a switch; when it happens that the transformers are near the control switch this is practical, but if the distance is great, the fact that all six of the secondary leads must be carried to the switch usually makes it impractical.

LETTERS

Mr. Scarborough's Three-Phase System

Referring to the wiring diagram of D. W. Scarborough, in POWER of Mar. 19, I do not see how he can have his load evenly balanced. If he takes his circuits from the wires *A* and *B* and *B* and *C*, that will be using only two phases, causing the ammeter in the leg *B* to read twice as much as either *A* or *C*; the combined readings of the ammeters in *A* and *C* will be equal to the reading of the ammeter in *B*.



MR. SCARBOROUGH'S DIAGRAM

When I took charge of the plant where I am now, which is a three-phase, three-wire system, our lineman commenced connecting up by taking branch lines from the legs *A* and *B* and *B* and *C*, and the result was an unbalanced load. I then told the lineman to take branches from *A* and *C* also and thereby balanced the load on the generator.

F. M. BENJAMIN.

St. Cloud, Fla.

[Mr. Benjamin is right in his contention that Mr. Scarborough's three-phase system was not balanced. Mr. Scarborough was probably misled by the fact that the ammeters in the legs *A* and *C* indicated equal loads. For correct three-phase balance, all three ammeters must read alike. Mr. Benjamin is in error, however, in assuming that an ammeter in the leg *B* will indicate as much current as both of the others added together. On account of the phase relations, the current in the wire *B* would be only 87 per cent. of the sum of the other two currents if they were equal. That is, with 100 amperes in *A* and an equal current in *C*, the current in *B* would be about 173 amperes, if no load were connected between *A* and *C*.—EDITOR.]

The United States Geological Survey's estimates of the coal areas of Texas show that the bituminous fields known to contain workable coal cover 8200 square miles. The estimated original supply of bituminous coal in Texas is placed at 8,000,000,000 short tons. From this there had been mined to the close of 1910 a total of 20,056,941 short tons, which represents an exhaustion of approximately 30,000,000 tons, the exhaustion being one-tenth of 1 per cent. of the original supply. The supply left in the ground at the close of 1910 would be equal to 19,000 times the production of that year.

The first shipment of petroleum from the Gemsah field of Egypt was recently made, consisting of 3000 tons in a tank steamer. The Gemsah oil field is on the Red Sea.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

An Experience with an Otto Engine

By A. Ulmann, Jr.

Many an engine badly treated has given the gas-engine industry a setback due to the prejudice aroused by what seemed to be the inability of the engine to fulfill the requirements. In nearly every case these failures can be traced to ignorance and neglect on the part of operatives or to the fact that the engine has been applied to work for which it is not suited. As a further proof of these oft-stated facts, I wish to submit to my fellow readers an experience that fell to my lot.

Among other equipment that came under my charge about two years ago, was a 40-hp. German-built Otto engine using alcohol for fuel and belt-connected to a fiber-extracting machine. This engine had been giving very poor satisfaction, and apparently could not pull the load required; it stood still as much as it ran, defied all attempts to start it and consumed alcohol with the prodigality of a New Year's Eve drunk.

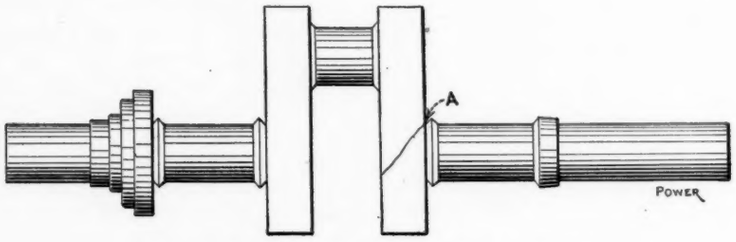


Fig. 1. Showing Where the Shaft Failed

The first thing that was noticeable was that the engine had but one flywheel in place of two, and, although the shaft stub for the second wheel ran in full sight, no one seemed to know what it was there for. The engine was "quantity governed," and when it did run the governor cam jumped back and forth like a shuttle and the speed of the engine varied about 20 per cent. In locating the cause of this trouble it was found that the inlet and exhaust valves did not open sufficiently and that the igniter worked very badly, missing about one in five explosions; also, the governor springs were so weak that the engine ran about 10 per cent. below its rated speed.

After these faults were corrected, the engine ran much better but still it would not pull the load required; the igniter still missed fire and the gases blew past the piston very badly. Then it was decided to give the engine a thorough overhauling and if possible cure the remaining defects.

Both main bearings and the crankpin bearing were rebabbitted, and an old cast-iron flywheel of approximately the weight of the missing one was bought and keyed in place. But upon taking out the piston a horrible state of affairs came to light. The piston and liner had been burned through lack of oil until their surfaces were as hard as glass and were gouged and scratched very badly. The rings were burred into the grooves so that they had to be taken out in pieces with a cape-chisel as no file would cut the burrs due to the hardening of the surface of the metal by the frequent heatings to which it had been subjected. Luckily a spare set of rings were discovered stowed away under a pile of junk in a locker.

Worst of all, it was evident that some mechanical genius while putting the wristpin into the piston had neglected to push it home so that the setscrew in the piston boss could enter the hole drilled in the wristpin for that purpose. The result was that the wristpin had backed out and come in contact with the cylinder liner, wearing two grooves in it about ⅛ in. deep and the length of the stroke.

This state of affairs, of course, in conjunction with the condition of the piston, made a new piston and liner absolute necessities. These were ordered from Germany and a piece of $\frac{3}{16}$-in. iron plate was inserted between the crankpin bearing-box and the connecting-rod stub to lengthen the rod and thereby reduce the clearance of the engine; this gave higher compression and therefore reduced the likelihood of misfire. After cleaning everything, taking up all lost motion in the valve rods and lay-shaft bearings and tightening the governor springs, the engine was put into operation and with careful handling and lots of lubricating oil gave fair satisfaction for three months until the new piston and liner arrived.

During the interval, however, one more accident occurred to this engine. One morning about 9 o'clock I received notice that the cylinder had cracked, and making all haste to the factory I found that the water jacket had cracked along the top of the cylinder from the head end forward about 6 in. to a boss in which was threaded the outlet pipe for the water circulation. Upon removing the cylinder head the entire water jacket was found to be thickly coated with scale. Due to the vibrations of the engine, a large piece of this scale had become detached and when the circulating water came in contact with the bare iron the crack was caused by the resulting rapid and uneven contraction. This was repaired with a patch of ¼-in. iron plate held in place with a number of ⅜-in. tapscrews tapped into the water jacket. Before tightening in place a liberal coat of Smooth-On cement was applied to the cylinder beneath the patch.

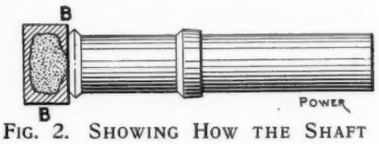


Fig. 2. Showing How the Shaft Failed

This answered the purpose admirably and gave no further trouble. Needless to say, all the scale was removed from the water jacket; to do this we used hydrochloric acid and long-handled scrapers inserted in the water ports that furnish the circulation to the cylinder head.

With the new piston and liner this engine ran well and for two years it pulled a load which steadily increased, due to the demands of manufacture; although I continually asked the owners for additional engine equipment, it was never forthcoming. The engine finally could stand no more and one day the crankshaft broke as indicated at *A* in the sketch, Fig. 1. It will be evident from this sketch that the shaft embodied a very bad feature of design, namely, the sharp reëntrant angles between the bearing journals and the cranks. The metal did not show crystallization at the fracture, but the break seemed to have been

caused by an incipient crack working its way into the metal from the apex of the reëntrant angle, as indicated in Fig. 1, until the entire interior of the crank cheek was separated. The outside metal *BB*, Fig. 2, held a while and finally sheared off, as was evident from the character of the break. There was no other immediate cause for the fracture as no part of the engine had become overheated and it had run well all day, except that it had been subjected to an overload so severe that at times it nearly stopped.

Gas Samples by Express

By G. W. Munro

Many producer-plant operators would doubtless be glad to have authoritative analyses of their gas output, but lacking both the necessary chemical equipment and technical skill, feel entirely helpless in the matter. Such may be interested in the experience herein recited.

Some time ago, the unsatisfactory operation of a gas-power plant made it necessary to fix the responsibility as between producer and engines, which were furnished by different makers. The engine specifications called for a certain minimum heat value in the gas, and these specifications had been accepted by the producer builder. The issue therefore was the quality of gas furnished, and there was no apparatus within a hundred miles for testing gas.

Rather than make another trip, I had two tin cans, holding about 2 gal. each, made as shown in the accompanying sketch. These were used to transport samples of gas for analysis, the samples being taken, the ends of the cans dipped in paraffin, the cans boxed and shipped

Holder for Carrying Samples of Gas

by express to the nearest laboratory. The samples were analyzed, the cans returned and refilled with other samples representing other running conditions, and sent back to the laboratory.

The analysis of a few samples showed that the producer was at fault and it was rejected. Before placing the order for a new producer to take its place, samples were taken from a producer already in service like the one under consideration and its suitability for the service thus practically predetermined.

Twelve samples were shipped in this manner over distances ranging from 100 to 500 miles. One shipment, misdirected, was about two weeks in reaching its destination, yet not a sample showed even a trace of oxygen, showing conclusively that no air had become mixed with the gas during shipment or handling.

For handling gas samples in this manner certain precautions are necessary. In filling the can from a pressure system the process is very simple; it consists merely in attaching one pet-cock of the can to a similar one in the gas main by a rubber tube, opening both pet-cocks and allowing the gas to flow through for some time to be sure that the air is all expelled.

The cock at the free end of the can must be closed first, of course, in order to trap the gas in the can under pressure.

In a suction plant the gas may be collected over water, first saturating the water to be used by shaking it in contact with some of the gas. Water from the scrubber, if not too dirty, should be suitable for the purpose. Great care must be exercised in making connection to the gas main to see that there are no leaks, for any leak, however small, will admit air to the sample and spoil it. A second can should be connected to the free end of the sampling can so that it may be partly filled with gas which may later be forced back into the sampling can to raise the pressure above the atmosphere. This will make the direction of any leakage outward, which results only in losing a little gas, whereas leakage inward spoils the sample.

In removing the sample for analysis, the chemist should heat the can enough to get the required sample rather than displace it with water, as the introduction of unsaturated water results in absorbing some of the carbon dioxide and thereby changing the composition of the remainder of the sample, making a check analysis impossible.

A Producer Gas Experience

By George L. Markland

Our power plant consists of a 50-hp. tandem producer gas engine, with its accompanying suction gas producer. This equipment replaced two gas engines—one of 22 hp., the other of 20 hp.—which had formerly made up our power equipment, and which operated on city gas.

When the new producer plant was installed it ran well for about six weeks, but our man, who had had no experience with producer plants, adjusted the governor until the engine was running on air regulation. As the producer gas became more or less rich, the valves had to supply a proportionate quantity of air, or backfire resulted. In other words, the governor was adjusted too close to regulate properly.

After this difficulty was overcome the question of coal became a serious one. We first arranged for a supply of pea coal, for which we paid $4.35 a ton. This coal clinkered badly in the producer. Consequently we had to keep the men overtime until 7 or 8 o'clock at night to break out the clinker with sledgehammers. This kind of treatment threatened to destroy the generator, so we invited five different companies to send us each a ton of coal and explained to them the conditions the coal had to meet.

One lot of coal made a beautiful fire, but absolutely no gas. Another kind gave fine gas, but ran into clinker as hard as flint. Finally one company suggested that we try a ton of buckwheat coal which had given excellent satisfaction in other producer plants and which cost only $3.50 a ton. This coal we are still using, and while we have some clinker, the quantity is small and causes us practically no trouble. The coal is delivered to us in 15-ton lots and runs uniform.

In the third place we had to experiment with the time of charging the generator with coal. At first we charged it every two hours, but found that it was frequently necessary to use city gas in order to carry the engine over the period of charging. By charging the generator every two hours we saved stoking through the top and prevented the clinker forming, but the method proved to be impracticable, as the engine sometimes dropped its speed and stopped entirely during the time we were charging the generator.

We have found it advisable, therefore, to charge it at night when our factory closes and to charge it again in the morning at 7 o'clock after raking the fire and poking it down.

We have had, too, some amusing experiences, alarming at the time they happened, but always proving to be very simple after investigation.

In the first place one of the men who erected the engine left a ½-in. nut in the governor case, and after we had been running the machine about four days this nut interfered with the governor balls, broke the stem and shut down the engine. After searching an hour and a half, the trouble was discovered and remedied.

A month later, after the governor had been adjusted so closely that we were depending on air regulation by valve, we got a terrific backfire because of the bad mixture, which turned the material in the dry purifier upside down, and again the engine stopped. In this case we started the engine on city gas and later in the day discovered the trouble.

Of course, all these things affected the men in the shop so that they began to look upon the plant in the nature of an experiment, but anyone who reads these experiences will realize that all of our troubles were due to neglect, ignorance, or carelessness. Our chief difficulty has been to overcome the prejudice among our employees.

The engines which were displaced by the present equipment produced bills with the city gas company which averaged $120 a month. The cost of labor was

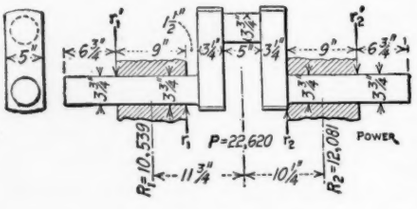
about $25 a month. The labor cost on the present equipment is $45 a month, but the cost for fuel is only $30. In addition we charge up 60c. worth of kerosene a month for the new plant. We found it necessary to soak the governor cage in kerosene all night, replacing it in the morning before starting the plant; this gave much better speed regulation. The other expenses incident to the power equipment are the same now as when the old equipment was in operation, except that the fire insurance rate has been increased because of the installation of the producer plant. The additional monthly expense for this is $6.50. We are arranging, however, to make changes in other parts of the plant which will reduce the insurance enough to offset the increase mentioned. Even with this increase, we are saving $62.90 a month by using the producer gas equipment.—*Factory.*

CORRESPONDENCE

Weak Crankshafts

The casualty insurance reports printed in POWER from time to time are of much value to those interested in engine design. The writer is sometimes called in at the "inquest" in similiar cases and it seems remarkable that there are so few failures and practically no cases of human injury when some of the commercial constructions are considered. Too many large engines have failed because the design was based on successful practice with small engines where requirements and service were the easiest possible.

Herewith is shown a sketch of a ridiculously weak shaft used in a 12x 16½ illuminating-gas engine with 70 lb. compression. It is necessary to retard the ignition of this engine to such a degree that the maximum pressure is limited to 200 lb. per square inch in order to get



smooth operation of the engine. If the engine is adjusted for power and economy of fuel, the springing of the shaft and bed is alarming. Many of these engines are in use and every one of the larger ones is a menace to life and property. Their shaft failures are so frequent that some provident owners keep a shaft on hand constantly, some engines having broken three shafts so far.

Assuming reactions at centers of the main bearings as stated on the sketch, the maximum fiber stress at the center of the crankpin on starting would reach practically 24,000 lb. per square inch.* Assuming a terminal inertia of reciprocating parts of 60 lb. per square inch of piston area, the unit stress when up to speed would reach $\frac{140}{200}$ of 24,000, or 16,800 lb. per square inch.

When these engines are new and the bearings are snug, these stresses are of course never reached as the deflection causes the reaction points to move inward closer to the inner edges of the bearings as at r_1 and r_2. This localizes the bearing pressures, the babbitt is soon beaten out and the reaction points spread until finally the great deflection and the recurring of heavy stresses cause fatigue and ultimately fracture of the shaft.

ALOF ALOFSEN.

Philadelphia, Penn.

Curing a Leaky Exhaust-pipe Joint

The owners of a gas engine installed for driving the machinery in a fairly large factory were troubled by leakage of spent gas from the exhaust connections of the engine into the room where the engine was situated, which was so serious that it had to be remedied.

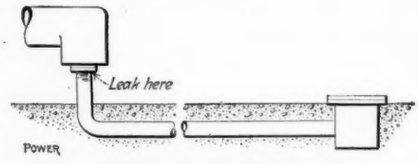


FIG. 1. ARRANGEMENT WHICH CAUSED LEAK

Examination showed that the cause of the trouble was due to the inflexibility of the exhaust pipe and muffler. These can be more clearly understood by reference to the two sketches herewith shown. As originally installed, the muffler was buried solidly in the floor and connected, by means of a fairly long pipe with a bend in it, to the exhaust outlet of the engine, the joint being made by means of a flange screwed on the end of the pipe. (See Fig. 1.) It will be evident that with this arrangement the muffler formed a rigid support for one end of the pipe and the flange the support for the other end. When the engine was under full load, the escaping exhaust expanded the pipe to such an extent that severe strains were thrown on the joint, causing it to become leaky. Eventually the matter was remedied by making the muffler movable and putting it on rollers, as shown in the second sketch.

To do this the pit in which the muffler was placed was enlarged both in width and in depth and beneath the muffler were placed two small pieces of gas pipe which served as rollers. With this arrangement, the muffler moved forward on the rollers when the pipe expanded and when

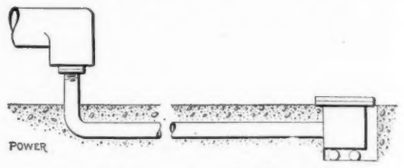


FIG. 2. MUFFLER ON ROLLERS

the engine was shut down it rolled back to its old position. This effectually remedied the trouble, which had threatened to become very serious from the owner's point of view.

J. A. SEAGER.

Bristol, Eng.

*Let P = Maximum pressure on crankpin
R_1 = Reaction at center of bearing B_1
R_2 = Reaction at center of bearing B_2
J = Section modulus at center of crankpin
M = Bending moment, inch-pounds
S = Unit stress at center of crankpin

Then $P = 12^2 \frac{\pi}{4} \times 200 = 22{,}620$

$R_1 = \frac{10\frac{1}{2}}{22} P = 10{,}539$

$R_2 = \frac{11\frac{3}{4}}{22} P = 12{,}081$

$J = 0.098 \times (3\frac{1}{4})^3 = 5.168$

$M = 11\frac{3}{4} \times 10{,}539 = 10\frac{1}{4} \times 12{,}081 = 123{,}830$

$S = \frac{M}{J} = 23{,}960$

Erratic Speed Variation

Irregularity of speed in gas engines is usually caused by either faulty governor mechanism, overheating or misfiring. The two last-mentioned troubles are easily detected and their correction may or may not be a simple matter. It is the first-named fault with which this short letter deals.

The pins and joints in a governor mechanism may have become so worn by continuous use that they are slack in one position and tight in another, thereby causing irregular governing. The larger components of the governor mechanism, however, may also cause trouble, as will be seen by the following experience which recently came under the writer's notice. A twelve-year old gas engine of about 4 brake horsepower was fitted with a hit-and-miss governor. This engine would run steadily for a time, then suddenly speed up or die down about 10 per cent. of the normal rate of speed, maintaining the abnormal speed for a few minutes at a time.

After much thought and guessing it was found that the camshaft, the bearings of which had become considerably worn, would shift along axially, and the thrust from the skew-wheel on the crankshaft would force the bevel gear driving the vertical governor spindle tight against the gear on the latter with which it meshed. This caused the governor spindle to bind, and the governor then lost its sensitiveness. Fitting thin washers between the boss of the skew-wheel on the side-shaft and the camshaft bracket cured the trouble.

JOHN S. LEESE.

Manchester, Eng.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Hot Water Heating for Institutions*

By Ira N. Evans

It is almost the universal practice for such large institutions as hospitals, colleges and asylums of various kinds, comprising a group of buildings, to provide the heating from a central plant as a matter of both low first cost and economy of operation. Hot water by forced circulation is particularly well adapted to this class of work, and when the magnitude of the plant is over 10,000 sq.ft. of radiation the operating cost should be less than for a steam system on a proper layout. The larger the plant the less in proportion will be the cost of heaters and pumps to the whole.

Inasmuch as this method of heating was first applied to shops and factories in connection with the use of exhaust steam from the power plant, many have assumed that it was more or less limited to this class of work. The applications are just as varied as those of steam heating with the added advantage that the water system, having a variable temperature of the medium independent of the power of circulation, has the same economy in the use of steam, whether exhaust or live steam is used on the system.

This point is of especial importance in connection with this class of work, as the power load is generally greatest at night, when lighting is required for a comparatively few hours, and during the day the exhaust steam is insufficient for the heating requirements. College work to a great extent is discontinued during the summer months and the regular terms comprise the months of the heating season.

It may be readily seen that if the heating medium is maintained at a nearly constant temperature of 212 deg. instead of a variable temperature averaging 160 deg. throughout the heating season, that the live-steam requirements would be greater if the power load did not furnish sufficient exhaust steam. If automatic heat control is provided and maintained in proper working order, the steam system will be economical, but will be high in first cost and maintenance.

If pressures are varied below atmosphere it will mean work for the vacuum pump to overcome the air leaks of the piping and larger mains will be required for the same output. These vacuum pumps use about 125 lb. of steam per horsepower-hour and the drain traps provided for removing condensation from the steam mains at distant points are a continual source of waste and expense, especially where grades are such as to interfere with a gravity flow to the power house.

A steam system designed to operate economically on live steam under pressure is uneconomical for exhaust operation or impossible, and one arranged to operate on exhaust at low pressure is uneconomical when operated on live steam due to the constant temperature and pressure impressed.

It is of frequent occurrence in large steam plants where the distances are great that the condensation requires a considerable length of time in returning

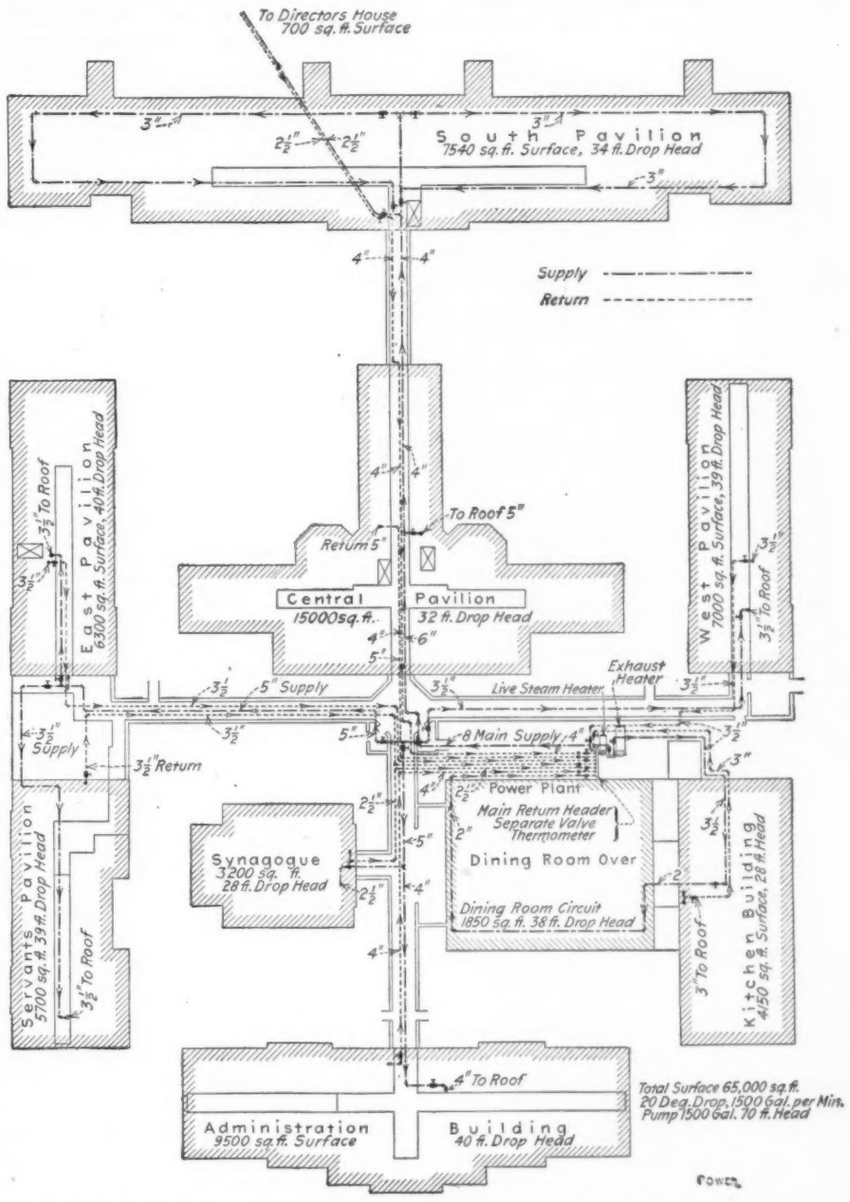


Fig. 1. Arrangement of Mains with Single Flow and Separate Returns

*Copyrighted 1912, by Ira N. Evans, consulting engineer, 156 Broadway, New York City.

to the power house, and make-up water has to be provided in the meanwhile for boiler feed. The condensation returning afterward remains in the return tank, if it is large enough, and loses its heat or is passed into the overflow and is wasted.

These difficulties are more serious where live steam is used for heating than when there is ample power to provide exhaust steam. They are entirely absent in the operation of the hot-water system as no steam is taken outside of the power house and the water temperature from the entire plant can be perfectly regulated to suit outside weather conditions without automatic heat control.

The water system with the same amount of radiation as for steam at 212 deg. will average about 160 deg. throughout the heating season and only about 6 per cent. of the time will maximum temperature be required.

If the steam system averaged 212 deg. and the water 160 deg. with the same radiation and the rooms 70 deg. in both cases, the steam transmission would be at the rate of 212-70 deg. and the water at 160-70 deg., or 142 and 90 deg. respectively. This would mean that $^{90}/_{142}$ or only 63 per cent. of the heat used in a steam system would be required for a water system. The condensation from traps and losses from the use of pumps and receivers, which may amount to 15 per cent. more, are additional. It is also clear that when the power load would be sufficient in the case of water in all moderate weather the steam system would require the addition of live steam continuously except at the time of the peak lighting load when the heating requirements would be minimum.

As a rule, the heating engineer seldom considers the heating load in moderate weather in temperate climates, but bases all calculations on the maximum load at 212 deg. This is caused by the inability to vary the temperature of the medium to any extent when considering the low-pressure steam system. As the exhaust steam is considered insufficient no attempt is made to increase the economy of the engine equipment for power. Carried to an extreme in some cases, this causes a surplus of exhaust steam after the plant is in commission.

In a water system the average load is the most important as the engines might be compounded with economy and vacuum carried in some cases. No steam is taken outside the power house as live steam is utilized in the live-steam heater with gravity return to the boilers, and the exhaust is used in the exhaust heater under partial vacuums, if conditions are favorable. If the exhaust from the circulating pump, with a steam consumption of not over 26 lb. per horsepower-hour, is used in the heating system, the friction of the water in the mains will about produce heat sufficient to balance that lost by the pump.

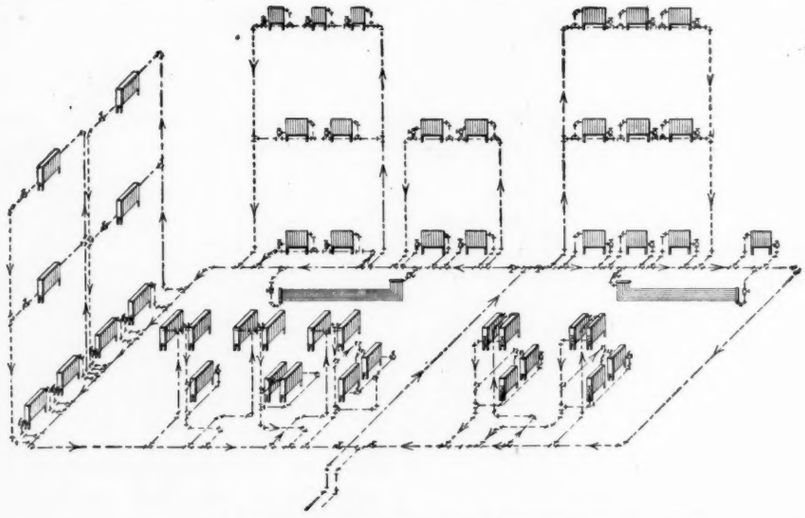
Regardless of any claim to the contrary, any group of large buildings will require continuous operation of the heating system on account of the extra boiler power necessary for intermittent heating. There is no economy in fuel in intermittent operation.

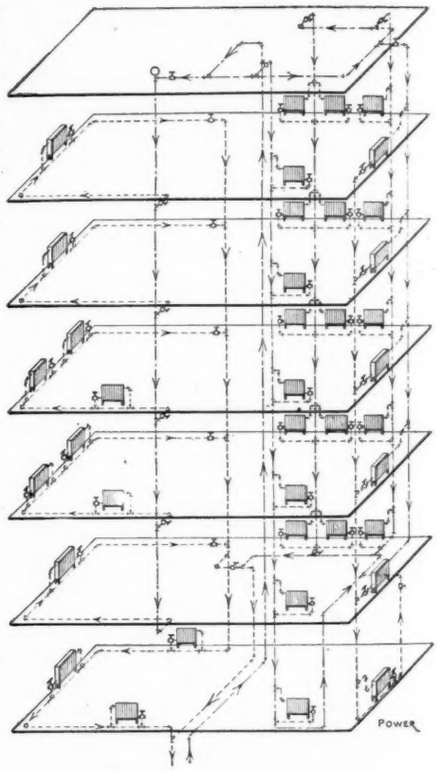
There are two methods of handling the live steam for heating on a hot-water plant of this character. First, when the exhaust steam just balances the heating in moderate weather, and power is operated 24 hr. per day, requiring live-steam operation at long intervals only, the condensation may be discharged through a high-pressure trap into the steam space of the exhaust heater. The pump or other method of removing the condensation of the exhaust heater will answer for both.

Second, where the live-steam heater is required a considerable portion of the time, as would occur when there was little or no power at night, the regular method of returning the condensation to the boiler by gravity should be employed. In most plants of this character there will be a surplus of exhaust steam during the peak of the lighting load a few hours in the evening. Under these conditions the exhaust heater, if the load is of sufficient magnitude, should be arranged to carry some vacuum. With the outbound water at 160 deg., 20 in. of vacuum could be carried and the heating system used as a condenser to the extent of its capacity. This would decrease the steam consumption on the power units so that possibly no more exhaust steam would be furnished under the greater power load than would exactly balance the heating requirements, or the same amount as when there was less power load and no vacuum.

In case the peak lighting load should be somewhat in excess of the heating requirements, a small cooling tower could be used to help out and regulate the vacuum on the heating system. If the heating required 5000 lb. of steam per hour at 160 deg. and 20 in. of vacuum and the power load furnished 8000 lb. at the same vacuum, a cooling tower for 3000 lb. of steam would enable vacuum to be carried on the entire peak load and the condensing capacity of the heating system, or 5000 lb., would be obtained for nothing.

In summer, the lighting load and the number of hours duration are so re-





FIGS. 2 AND 3. TYPICAL ARRANGEMENTS FOR PIPING AND RADIATION IN BUILDINGS

duced on this class of plant that the small condensing equipment would be sufficient.

In most institutions of this class considerable mechanical ventilation is required, especially in the lecture rooms of colleges. One of the mistakes of the heating engineer has been over-ventilation of these buildings or the installation of a system so designed as to compel operation by combining it with the heating. It is well known that when outside air is heated to 70 deg. for ventilation or 120 deg. for heating and ventilation combined, the fuel requirements increase two or three times over heating by direct radiation. The operating force, not having any endowment to purchase coal, finds a big saving in fuel by eliminating the ventilation when possible. Undoubtedly many doctors have condemned a system of ventilation that has ceased to be operated.

It is a great mistake to heat buildings with steam, and a hot-water system for the direct surface. This is expensive and entirely unnecessary as both the indirect and direct surface can be operated from the same hot-water mains on a properly designed system. This does away with the duplication of the heating systems and all fans can be operated by motors supplied by current from the main engines which furnish the exhaust for heating.

In designing a hot-water plant the mains should be arranged so as not to bypass and require local regulation of the flow. This can be accomplished by balancing the distance as well as the friction heads on the different circuits, and making the direction of flow the same on the return and supply mains as in Fig. 4. In this layout, due to the proper sizing of pipes, the drop in head across the mains is nearly the same throughout the circuit, regardless of the drop in head along each main.

ers for the same difference in temperature. It also brings the outboard temperature of the water nearer to that of the exhaust steam; this is a great advantage in steam consumption for power where turbines are used under partial vacuum. It also makes the system as a whole more responsive to regulation and facilitates changes in water temperature to suit outside weather conditions.

In most institutions live steam at comparatively high temperatures is required the year round; in colleges for chemical laboratories and in hospitals and asylums for sterilizing, cooking, boiling, kitchens, laundries, etc. This corresponds to steam in a factory for maunfacturing purposes and for economical operation should be on a separate line from the heating.

Fig. 1 shows a layout of mains for a large city institution. The buildings are fed from a single 8-in. supply main which is reduced as the connections are

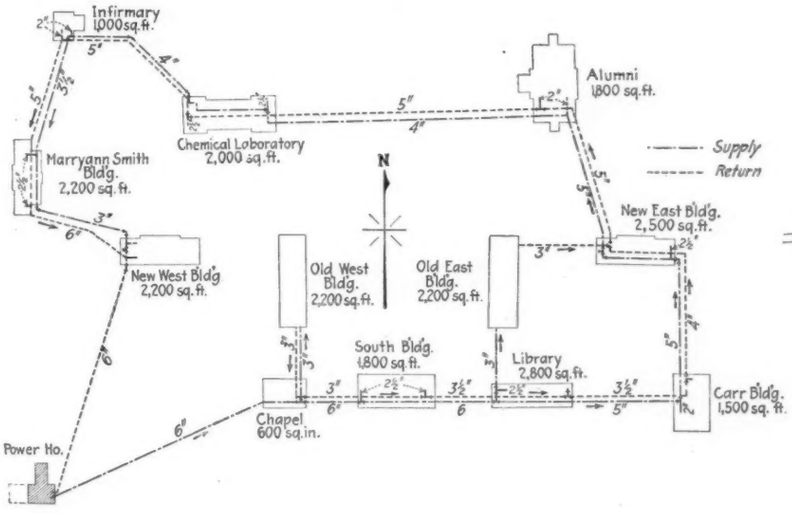


FIG. 4. SUPPLY AND RETURN SYSTEM

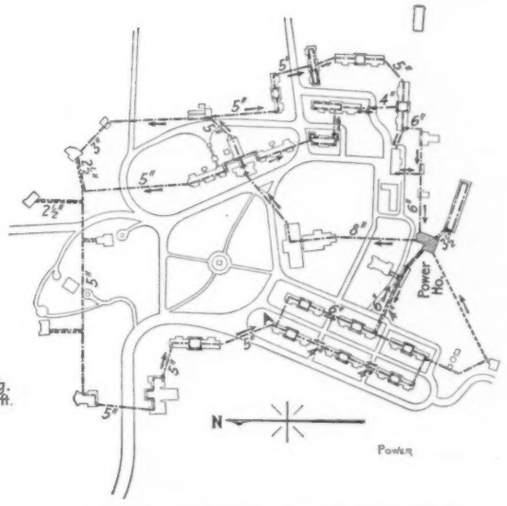


FIG. 5. SINGLE PIPE SHUNT SYSTEM

with a hot-water system operating on low temperatures entirely by indirect radiation. If low water temperatures are actually used, the cost of both installation and possibly the operation will be excessive, to say nothing of the bulk of the apparatus. If the cost is reduced, it will result in high temperatures of water and uneconomical engine operation, in some cases requiring live-steam operation entirely in extreme weather.

The proper way to design a system of this kind is to furnish slightly less direct radiation than required for the radiation of walls and glass, and provide fresh air at 70 deg. in such quantities as will give the number of occupants the proper supply. The rooms should be arranged so that the air supply can be discontinued when unoccupied and the temperature maintained by the direct radiation only.

Some hospitals have been arranged with a separate system of ventilation

The balancing of distances may be omitted on small jobs where low velocities and comparatively large mains are used, but it is absolutely essential where high velocities and long distances are involved to obtain the proper discharge without individual regulation by means of lock stop valves.

As the radiation of the mains is an important item, every inch that the mains are decreased in diameter reduces the surface $3^1/_7$ times and the extra power is compensated for in the heat due to the friction returned to the water. The only limit to this is the use of the single-stage pump which will not produce heads of much over 125 ft. with economy. If the distances are long, the drop in head per 100 ft. will have to be reduced. The drop in temperature should not be over 20 deg., and 15 deg. is better. This brings the average temperature lower throughout the system and increases the transmission of both radiation and heat-

taken off. Each building has an overhead system with single 1¼- or 1½-in. risers, the radiators being connected in shunt as shown in Fig. 3. Several arrangements of piping to the radiator are shown. Attention is called to the method of connecting radiators in the basement with the return main on the ceiling. Fig. 2 shows the arrangement of the south pavilion for buildings under four stories, with radiators connected to a single main on the basement ceiling.

Figs. 2 and 3 show nearly all the basic methods of arranging piping for this class of building. Each building has a separate return to the header at the pump, Fig. 1, with a valve and thermometer. This arrangement allows of no complication in figuring the drop in friction head and the valves at the header provide additional regulation besides that of the water temperature. The live-steam heater is arranged with a trap to discharge into the steam space of

the exhaust heater as it will not be needed except in extreme weather as the power plant is operated 24 hr. per day. The exhaust heater is arranged to utilize the vacuum on the engines due to the temperature of the water. Where indirect radiation is provided for ventilation it would be good practice to connect it to the general supply main with a separate return or to a separate loop with the indirect stacks connected in shunt.

Pipe coils are most efficient and will be found cheaper in the long run than cast-iron indirect surface for this work. The cast-iron surface may cost slightly less, but the testing and replacing of a very few broken sections will soon make up the difference.

The separate return mains will not cost any more than the large single return outside of the covering, and the advantage in central regulation obtained will more than pay the extra cost. This is appreciated when it is necessary to vary the circulation in the buildings due to the changes in direction of the wind.

Hot-water domestic service may be handled by a separate system of piping in the same manner as the hot-water heating with circulating pump exhaust and live-steam heaters. This service, however, should never be connected to the heating mains or any water be allowed to be displaced in the heating system proper, as the piping will deteriorate. On the hot-water service galvanized or brass pipe should be used, on account of the displacement of water. It will be found that much smaller mains may be used and considerable economy of first cost and operation effected by this arrangement of the domestic service and the circulation will be positive and sure.

The expansion tank should be placed in the engine room and handled by air pressure with automatic air traps at all high points.

Fig. 4 shows a group of isolated buildings with a supply and return. This plant is actually laid out with a 6-in. main with radiation shunted in the different buildings. It was taken as an example to show the advantage in cost of the single-pipe system. With a velocity of 7 or 8 ft. per second in the 6-in. main, sufficient drop in head is obtained in the length of each building to produce circulation without lock-stop valves or chokes.

Fig. 5 shows a large home in the West with two single-flow branches, the main 8-in. branch being divided twice. This particular system requires adjusting valves at several points which could be avoided with a different layout. Where the 4-in. supply enters the return from the other section at *A*, the head in the supply is liable to be greater than that in the return and tend to reduce the velocity unless carefully regulated by valves at *A*. Circuits should be laid out separately so that there will be as little complication in the calculation of the drop in head as possible.

All of the plants shown can be installed for less cost than a steam system of the same capacity, when all items of cost are considered and the cost of operation will be about 30 per cent. less for heating and power combined. The requirements of institution heating are somewhat different from central town heating, as the latter, to be successful, must be wholly a byproduct plant with ample exhaust steam which must be utilized to the best advantage. The institution, on the other hand, has a fixed heating load to be provided for whether there is power or not. Due to the comparatively small amount of power required, they are in many cases live-steam plants a large portion of the time.

Many steam plants of this class are arranged to operate on vacuum systems with very low pressures when they would be more economical in first cost and operation if pressures above atmosphere were used on the distant buildings, only the near-by buildings being operated on exhaust steam. Due to the live- and exhaust-steam heater arrangement on the forced hot-water system and independent power of circulation, the same system of mains would be used with equal economy, whether exhaust- or live-steam operation were under consideration.

A vacuum on a live-steam system is an unnecessary expense in both first cost and operation, due to the requirements of the vacuum pumps and the reduction of the operating pressure through a reducing valve to nearly a constant pressure and temperature. The greater volumes of the steam at low pressure require larger mains for the same output, thus increasing the radiation losses in transit.

The repairs are greater on the pressure system, but the pressure to remove the air from the system and the ability to vary the pressure and temperature to suit outside weather conditions is not to be overlooked when coupled with smaller mains and less radiation.

One of the future fields of hot-water central heating will be in connection with high-class real-estate developments, the central plant furnishing domestic water, hot and cold, lighting and heating. This particular application involves the same character of load as for institution heating, the heating requirements being somewhat in excess of the power if the entire section is included. The method of obviating this difficulty is to furnish power to the whole section and only furnish heating for a portion to the extent of the power installation in boilers. The portion heated can be located so as to make it more desirable, and higher prices can be obtained for these lots. While the development is acreage, mains can be installed and operation started before the streets are turned over to the city, thus avoiding any conflict with terms in the franchises of existing public-service companies.

If alleys are reserved through the centers of the blocks and not turned over to the city as streets, the pipes can be laid through these on a single-pipe circuit, and, except for crossings, they can be kept out of streets altogether. Electric wire and water pipes could all be laid in the same conduit at comparatively small expense.

Afterward, the plant could be sold to the public-service company at a good profit, as it could operate the entire plot for heating to better advantage, shutting it down entirely in summer and providing lighting service from the outside mains.

With their mains from the main power station to absorb surplus current when the heating load was large, and to supply current when the heating load was small, they would have a distinct advantage over the developers. Where it would not pay the developers to extend the heating to the entire section, it would pay the public-service company to do so as it could utilize the surplus current at all times and eliminate the use of live steam on the heating system.

Cause of Pump Racing

In the issue of Apr. 2, Mr. Moulton's pump is caused to race by the condensation of steam in the heating system creating a partial vacuum and so holding the water back from the pistons. Vapor thus forms in the pump cylinder and, of course, the pump races and pounds until the system is up to atmospheric pressure again.

A remedy would be to install a large vacuum breaker, shut the steam off the system slowly or to stop the pump until the vacuum is broken.

M. J. MANN.

Ipswich, Mass.

With the use of superheated steam, it has become necessary to efficiently cover the high-pressure portions of the turbine cylinder with nonconducting material, because the metal on the inside of the cylinder in contact with the steam becomes hotter than that on the outside, especially at the edges of flanges and ribs. The inside tends to expand, and this expansion is resisted by the colder metal on the outside. As a consequence, if the temperature difference is great enough, the metal will be distorted and perhaps strained beyond its elastic limit. For this reason the design of the ribs should be carefully considered, the thickness of metal throughout the structure being kept as uniform as possible.—*Mechanical Engineer.*

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.

Monadnock Bldg., Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

FRED R. LOW, Editor.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $5 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 21 Shillings.

Entered as second class matter, December 20, 1910, at the post office at New York, New York, under the Act of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

Of this issue, 29,000 copies are printed.

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	Page
Aeolian Company's New Power Plant	680
Raising Water by Compressed Air	684
Red Lead Joints	685
New Arrangement of Superheater with Yarrow Boiler	686
Home Made Hoists	687
Draft in the Boiler	687
Steam Consumption per Horsepower Hour	688
Kinetic Theory of Gases and Steam	689
Loss by Throttling a Turbine	690
Transformer Connections	691
Mr. Scarborough's Three-Phase System	693
An Experience with an Otto Engine	694
Gas Samples by Express	695
A Producer Gas Experience	695
Weak Crankshafts	696
Curing a Leaky Exhaust Pipe Joint	696
Erratic Speed Variation	696
Hot Water Heating for Institutions	697
Cause of Pump Racing	700
Editorials	701-702
Efficiency of Joints in Boiler Shells	703
Generating Power as a Byproduct	705
Readers with Something to Say: New Valve Affects Economy....Ignored the Engineer's Advice....Knowledge Is Power....Drum Cord Attachment....The V-Thread on the Bolt....Remodeled Oiling System....Avoiding a Shutdown....Return-Tubular Boilers....Compressed Air Oil Lift	706-708
Questions Before the House: Pump Diagrams....The Critic Criticized....Centrifugal Pump Troubles....Valve Locking Devices....Central Station vs. Isolated Plant....Oil Pipe Leaked....Automatic vs. Fixed Cutoff for Compound Engines....A Pumping Problem	709-711
Inquiries of General Interest	712

POWER

The Technical Graduate and the Power Plant

Soon the technical schools throughout the country will be turning out another year's output of graduates into the engineering field. Many of these men have exaggerated ideas of their own worth as embryo engineers and will therefore seek positions with little hard work and which they believe will be short cuts to leading executive positions. As a result of this self-conceit, many will never get farther than the drafting board or the office desk that handles routine work—all small salaried jobs.

In the central-station and power-plant engineering field splendid opportunities are open for technical men. A broad practical experience is necessary, and this necessarily means starting as a helper in an operating plant. While the work is hard, steady and dirty, the hours often long, the pay small and promotion sometimes slow, the man's experience is growing and his usefulness increasing.

To meet the modern demand for high efficiency and scientific refinement, industrial executives in the future must put men in charge of their power plants who not only have the broadest technical and business training but who also have the widest practical experience. They will always be ready to pay well for a first-class man to take charge of these plants, as such a man may easily save his salary many times over in a year by the improved economies he may be able to effect.

When improvements or enlargements of the plant are to be undertaken, the chief engineer is usually consulted and his ideas given careful consideration before any changes are made. In most cases, he plans all such undertakings himself, even to making the designs. In looking over the lists of the members of the American Society of Mechanical Engineers, one is surprised to find that so great a number of the older and more prominent men in the field of steam engineering have at one time in their career served as operating engineers. It is therefore apparent that other and better positions of responsibility become available for the operating man as his experience increases.

It can be seen that in power-plant engineering there is a great and promising field of growing importance for the young technical graduate who likes machinery and is not afraid of a few years of hard work. Why should not such work be chosen in preference to apprentice courses with some large manufacturer of a single line of products?

Steam Mains and Steam Traps

So many articles have appeared in technical journals from time to time that one is surprised to note the number of mistakes that are still made in the design of new power plants. As a rule, these mistakes are due to the inexperience of designers with power-plant operation and many errors would be avoided if a competent operating man was called in and allowed to check over the plans. While sufficient provision is usually made for stresses and a proper material specified for the pipe and fittings, on the other hand, many of the operating features are frequently overlooked.

A serious accident occurred in a plant of recent construction in this country. The steam main was provided with tees to some of which the boiler leads connected on one side while the engine branches connected to others, all these connections being made on the sides of the main steam pipe. The drain system to the steam traps consisted of one-inch pipe connected to drilled holes on the bottom sides of these tees. The traps were standard and of a reputable make, but had very small water capacity. The power load fluctuated badly at times and one day the boilers commenced to foam. As no part of the steam lines could act as a catch-basin, the water went over direct to the engines; a disastrous wreck was the result.

If an operating engineer had checked this piping design, he would have prob-

ably made all the steam connections on the top of the header instead of at the sides, and would have provided a sufficient number of drip chambers or separators, to which traps could be connected. These devices would have mitigated to a considerable extent the possible damage to the engines if the boilers were to foam.

In operation, all steam traps should be inspected once every watch, though some operating engineers feel that they have made a satisfactory inspection when they tilt a trap or open its bypass and hear it discharge; almost any trap should discharge when treated in such a manner. The proper method is to provide an outlet on the discharge pipe so that the engineer can open it and actually see the trap discharge under working conditions at least once on his watch; this outlet will also serve as a telltale on leaky trap valves. The steam trap is a useful and serviceable adjunct to the steam plant, but it must be watched closely and kept in perfect condition at all times to make it give satisfactory service.

The steam-piping system is the main artery of the steam plant, so to speak, and the greatest care must be taken in its design and operation.

Byproduct Gas Producers

Most American inventors of gas producers have endeavored to produce tar-free gas from bituminous coal. Some have been quite successful and others have produced gas heavily charged with lampblack which has proved very troublesome around gas producers and engines.

The United States Steel Corporation is said to be producing coke at one of its new plants for almost nothing, the gas and byproducts practically paying for the coal and the cost of the coking process.

A large Mond gas-producer plant has been in operation at Dudley Port, near Birmingham, England, for several years, from which the byproducts, tar and ammonium sulphate, are recovered and sold. The gas is distributed through mains over a considerable area and practically no trouble has been experienced with tar in the distributing system, doubtless due to the careful and thorough washing given the gas after it leaves the producer.

It has always been objected that such a process could not suceed in America, owing to the difficulty of disposing of the byproducts. The American farmer is as progressive as any in the world and when he learns the advantages of ammonium sulphate as a fertilizer, the demand for this material will increase rapidly. The plant of the Steel Corporation already referred to seems to have no difficulty selling its byproducts.

Tar, usually considered a waste, may prove one of the most valuable of all the byproducts. The success attained in Europe in using tar-oils and even moderately thick tar as a fuel for Diesel engines opens up a wide field for this waste product.

European engineers have shown what can be done in developing new processes and utilizing new equipment, as, for instance, the producers and Diesel engines already mentioned. It is now time for an American engineer to design and build a producer-gas central station for one of our large cities. The byproducts from the bituminous coal could be saved and the ammonium sulphate marketed. The tar would be treated and such portions saved as can be used for fuel for Diesel engines. These engines could be located in substations and used only to carry the peak loads. The residue of heavy tar substances might be put into stills and subjected to a cracking process until all that remains is a coke which could be returned to the producer. Such a process would make available many cheap grades of bituminous coal and would entirely stop the smoke nuisance.

While many difficulties would have to be overcome, none are beyond our present engineering ability. Such a plant would probably occupy much larger floor space than a corresponding steam plant, but it could be located outside the city proper and the gas piped to large holders near the power plants. These plants could be located to minimize the distribution losses. By providing Diesel engines for peak loads, the central producer plant could operate steadily at nearly one hundred per cent. load factor. This economy of operation, with the high thermal efficiency of the gas engine itself, should make such a station highly profitable, even though the first costs may exceed those of a steam-turbine power plant of equal capacity.

The problems involved in such an undertaking are exceedingly intricate, but the possibilities warrant very careful consideration by our engineers.

Natural Sources of Energy

While the coal strikes abroad have wrought much hardship, one benefit at least has accrued. Attention has been directed to conserving fuel supplies and developing other natural sources of energy.

In its recent report—which is not complete—the British Science Guild shows that while almost unlimited supplies of energy exist, they are for the most part still inaccessible.

For instance, Sir William Ramsay estimates that a ton of radium contains four hundred and sixty thousand times the energy of a ton of coal, but the uranium ores of the entire world would not assay over five hundredweight (the equivalent in energy of one hundred and twenty-five thousand tons of coal); therefore, radium has no commercial importance as a fuel.

Another British physicist says that energy can be obtained by boring a hole in the earth twelve miles deep, where the normal temperature is two hundred and seventy-two degrees Centigrade, but we have no facilities for drilling the hole.

As an alternative to coal, the possibilities of oil were also discussed, says our British contemporary, *The Mechanical Engineer*. The present production of crude oil is barely sufficient to provide one-sixth of the power now developed by coal.

Sir J. J. Thomson last year estimated that, shining from a clear sky, the sun sends energy to the earth at the rate of seven thousand horsepower per acre, but in all attempts to utilize it only a small fraction has been recoverable as work.

Increased economy in the conversion of the heat energy of coal into mechanical work and reduction in the present wastes of fuel will defer the exhaustion of our coal resources, but hardly in proportion to the ever-increasing demand for power. That the coal supply will ultimately fail seems inevitable. Meanwhile, we must look for other means of obtaining power, and the present most promising are water and wind power. The development of these now will conserve the coal and must, with other possible sources of power that may become available, eventually take its place.

Efficiency of Joints in Boiler Shells

By H. L. Strong

Calculations showing how to figure the efficiencies of both lap and butt joints with single, double and quadruple riveting.

To many engineers, calculating the safe working pressure of a boiler shell or drum is a complex and difficult operation, especially that part of it which deals with the efficiency of riveted joints. Perhaps it is a little difficult to keep in mind all of the formulas, but if the principles governing the calculations are thoroughly understood, it then becomes a matter of ordinary arithmetic.

Assume a boiler shell the greatest internal diameter of which is 60 in., constructed of ½-in. steel having a tensile strength of 60,000 lb. per square inch. What will be the bursting pressure and the safe working pressure with several styles of riveted longitudinal seams? First, employ the usual formulas for bursting and safe working pressures; that is,

$$\frac{T.S. \times t \times E}{R}$$

and

$$\frac{T.S. \times t \times E}{R \times F.S.}$$

respectively, where

$T.S.$ = Tensile strength of material in pounds per square inch of cross-section;

t = Thickness of material in inches or fractional parts thereof;

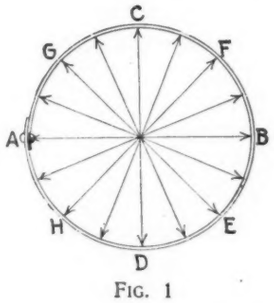


FIG. 1

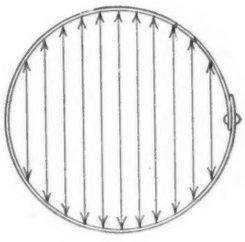


FIG. 2

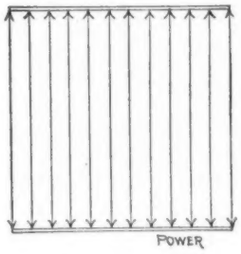


FIG. 3

REPRESENTING PRESSURES IN BOILER SHELL

E = Efficiency of longitudinal seam, expressed in decimals;

R = Greatest internal radius in inches;

$F.S.$ = Factor of safety.

Assume a factor of safety of 5 in all cases. Substituting the proper values in the formula the problem becomes

$$\textit{Bursting pressure} = \frac{60{,}000 \times 0.5 \times E}{30}$$

Just why the radius enters into the formula instead of the diameter or circumference may be seen by reference to Fig. 1, which represents a single-riveted ring, and as the pressure of liquids and gases is equal in all directions, it follows that pressure acting on the inside of the ring must be conceived as radiating from the center as indicated by the arrows. The weakest point in the ring is the riveted joint; therefore consider the strain on the ring at that point as at A, although it is equally great at B or at any other point. To understand how the pressure acts to pull the ring apart, one must conceive of the pressure acting equally in opposite directions, as indicated by the arrows above and below the horizontal line in Fig. 1. The forces acting at C and D are at right angles to the horizontal line and are therefore exerting their full effect, while those at E, F, G and H are acting at an angle and are less effective.

Fig. 2 represents the same action, and is perhaps easier to understand. The total effective forces represented in either Figs. 1 or 2, acting on the whole circumference, are equivalent to those shown in Fig. 3, which represents the unit pressure acting equally over two flat surfaces equal in length to the diameter of the shell. The boiler in the example under consideration is 60 in. in diameter; therefore force tending to pull the shell apart along the plane AB is equivalent to the pressure acting in opposite directions on two flat surfaces 60 in. long on which this tendency is resisted by the metal in tension at both A and B. But as only one side of the ring or the point at which it is riveted is being considered, only one-half of this surface should be taken. Hence the radius is used instead of the diameter; that is, dividing the strength of the joint in pounds per inch of length by 30 will give the pressure in pounds per square inch, which will theoretically cause it to fail.

If the ring were equally strong at all points it would require

$$\frac{60{,}000 \times 0.5}{30} = 1000 \textit{ lb.}$$

pressure per square inch to burst it.

To determine the efficiency of the joint or, in other words, just how strong the ring actually is, the American Boiler Manufacturers' rules for designing riveted joints may be employed. In these

d = Diameter of rivet hole = $2t$ (or approximately twice the thickness of the thinnest plate);

e = Distance from rivet hole to edge of plate = $1\frac{1}{2}d$;

P = Pitch of rivets = $3d$;

V = Distance between adjacent rows of rivets = $\frac{1}{2}P$;

l = Lap of plates = P.

The following symbols in the formula for calculating riveted joints are those commonly employed:

$T.S.$ = Tensile strength of plate;

t = Thickness of plate;

d = Diameter of rivets after driving;

P = Pitch of rivets on row having greatest pitch;

a = Cross-sectional area of rivets after driving;

S = Strength of rivets in single shear;

S' = Strength of rivets in double shear;

N = Number of rivets in single shear;

N' = Number of rivets in double shear.

Fig. 4 represents a single-riveted joint. In calculating riveted joints, a strip of

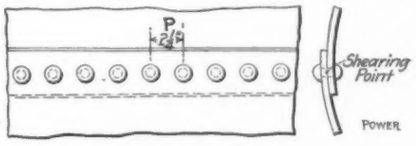


FIG. 4. SINGLE-RIVETED LAP JOINT

plate equal to a unit length of joint is considered; that is, a strip equal to the distance from center to center of two rivets on the row having the greatest pitch. This should not be confused with the 1-in. ring previously considered.

In the present example of a single-riveted joint, let the pitch be 2¼ in. Then this length of solid plate has a tensile strength of

$$60{,}000 \times 0.5 \times 2.25 = 67{,}500 \textit{ lb.}$$

which is the same thing as

$$P \times t \times T.S.$$

Call this quantity A. Let the rivets be $\frac{15}{16}$ in. or 0.9375 in. in diameter, after driving, and the net section of plate between the rivet holes is

$$2.25 - 0.9375 = 1.3125$$

and

$$1.3125 \times 0.5 \times 60{,}000 = 39{,}375 \text{ lb.}$$

the strength of plate between the rivet holes. This is equivalent to

$$(P - d)\ t \times T.S.$$

Call this quantity B. The shearing strength of the rivets per square inch of cross-sectional area may be taken as follows:

Iron rivets in single shear.....38,000 lb.
Steel rivets in single shear.....42,000 lb.
Iron rivets in double shear.....70,000 lb.
Steel rivets in double shear.....78,000 lb.

The shearing stress on the rivets, of course, tends to cut them in two, and in a properly designed joint the rivets should be able to withstand as great a stress as the net section of plate between the rivet holes.

Referring to Fig. 4, it will be seen that there is one-half of a rivet between the pitch lines on each side, which is equivalent to one rivet in a unit length (2¼ in.) of joint. A $\frac{15}{16}$-in. rivet has a cross-sectional area of 0.6903 sq.in., and

$$42{,}000 \times 0.6903 = 28{,}992.6\ lb.$$

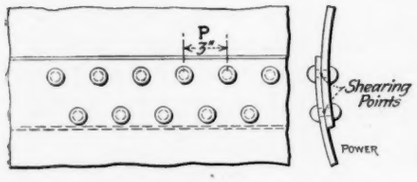


FIG. 5. DOUBLE-RIVETED LAP JOINT

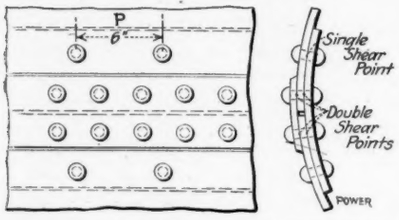


FIG. 6. DOUBLE-RIVETED BUTT-STRAP JOINT

the shearing strength of one rivet in single shear. Designate this as quantity C. Now,

$A = 67{,}500$;
$B = 39{,}375$;
$C = 28{,}992.6$.

Evidently, the joint will fail by shearing the rivets as C has the smaller value. Therefore, dividing C by A gives 0.429, or 42.9 per cent. as the efficiency of the joint.

Such a joint is unsatisfactory. The riveting is 10,375 lb. weaker than the net section of plate between the rivet holes and the efficiency of the joint is low. The boiler would burst at an internal pressure of

$$\frac{60{,}000 \times 0.5 \times 0.429}{30} = 429\ lb.$$

per square inch, and dividing 429 by 5 gives 85.8 lb. as the safe working pressure.

Now try double riveting with $\frac{15}{16}$-in. rivets (after driving), and 3-in. pitch. Fig. 5 represents this joint, and the only difference between the calculations for this joint and those for the single-riveted one is that there are two rivets in single shear instead of one.

Now, using the regular formula,

$$A = P \times t \times T.S. = 3 \times 0.5 \times 60{,}000 = 90{,}000\ lb.$$

$$B = (P - d)\ t \times T.S. = (3 - 0.9375) \times 0.5 \times 60{,}000 = 61{,}875\ lb.$$

$$C = N\ S\ a = 2 \times 42{,}000 \times 0.6903 = 57{,}895\ lb.$$

Again, C is the smallest value and

$$\frac{C}{A} = \frac{57{,}895}{90{,}000} = 0.643 \text{ or } 643\ per\ cent.$$

which is the efficiency of the joint. The safe working pressure is

$$\frac{60{,}000 \times 0.5 \times 0.643}{30 \times 5} = 128\ lb.$$

The joint is not satisfactory yet; hence a double-riveted, double butt-strap joint as indicated in Fig. 6 may be tried. In this joint there are two rows of rivets on each side of the joint proper, but those on one side only are considered. The inner row has a 3-in. pitch and the rivets are in double shear, the plate tending to cut them at two points, as indicated.

The outer row has double or a 6-in. pitch, and the rivets are in single shear. The pitch of the inner row of rivets does not enter into the calculations, merely

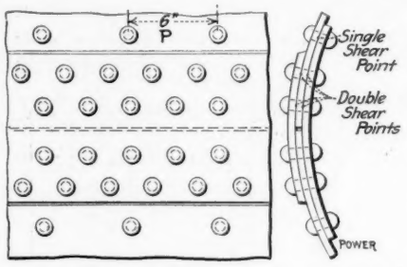


FIG. 7. TRIPLE-RIVETED BUTT-STRAP JOINT

the number of rivets and rivet holes and their size. Also, as the combined strength of the straps is greater than that of the shell plate, they are not considered. Using $\frac{15}{16}$-in. rivets, as before (after driving), and applying the formula

$$A = P \times t \times T.S. = 6 \times 0.5 \times 60{,}000 = 180{,}000\ lb.$$

or the strength of the solid plate in a unit length (6 in.) of joint.

$$B = (P - d)\ t \times T.S. = (6 - 0.9375) \times 0.5 \times 60{,}000 = 151{,}875\ lb.$$

or the strength of the plate between the rivet holes on the outer row.

$$C = N\ S\ a + N'\ S'\ a = (1 \times 42{,}000 \times 0.6903) + (2 \times 78{,}000 \times 0.6903) = 28{,}992.6 + 107{,}686.8 = 136{,}679.4\ lb.$$

the shearing strength of one rivet in single shear in the outer row, and two rivets in double shear in the inner row.

$$D = (P - 2d)\ t \times T.S. + N\ S\ a = (6 - 1.875) \times 0.5 \times 60{,}000 + (1 \times 42{,}000 \times 0.6903) = 123{,}750 + 28{,}992.6 = 152{,}742.6\ lb.$$

the strength of the plate between the pitch lines minus the two rivet holes on the inner row, plus the shearing strength of one rivet in single shear on the outer row.

It will be seen that a joint of this style might fail by breaking the plate between the rivets on the outer row (quantity B), by shearing the rivets in both rows (quantity C), or by breaking the plate along the inner row of rivets and shearing the outer row (quantity D). In this case the joint will fail by shearing all of the rivets, as C has the least value. Therefore

$$\frac{C}{A} = \frac{136{,}679.4}{180{,}000} = 0.759 \text{ or } 75.9\ per\ cent.$$

which is the efficiency of the joint. The plate is still stronger than the riveting, but the safe working pressure would be

$$\frac{60{,}000 \times 0.5 \times 0.759}{30 \times 5} = 151.8\ lb.$$

Now consider a triple-riveted double butt-strap joint as shown in Fig. 7. The only difference in calculating this one and the previous one is that in Fig. 7 there are four rivets in double shear instead of two, and in getting the quantity D the possible point of failure is taken as

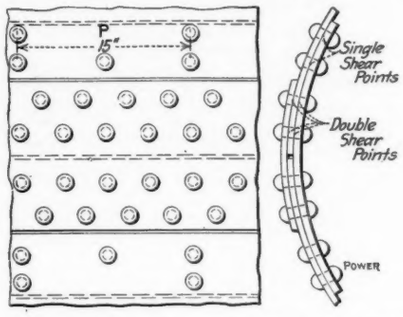


FIG. 8. QUADRUPLE-RIVETED BUTT-STRAP JOINT

along the second or middle row of rivets instead of the inner row. Then

$$A = P \times t \times T.S. = 6 \times 0.5 \times 60{,}000 = 180{,}000$$

the strength of the solid plate in a unit length (6 in.) of joint.

$$B = (P - d)\ t \times T.S. = (6 - 0.9375) \times 0.5 \times 60{,}000 = 151{,}875$$

the strength of the plate between the rivet holes on the outer row.

$$C = N\ S\ a + N'\ S'\ a = (1 \times 42{,}000 \times 0.6903) + (4 \times 78{,}000 \times 0.6903) = 28{,}992.6 + 215{,}373.6 = 244{,}366.2\ lb.$$

the shearing strength of one rivet in single shear on the outer row plus the shearing strength of four rivets in double shear on the middle and inner rows.

$$D = (P - 2d)\ t \times T.S. + (N\ S\ a) = (6 - 1.875) \times 0.5 \times 60{,}000 + (1 \times 42{,}000 \times 0.6903) = 123{,}750 + 28{,}992.6 = 152{,}742.6\ lb.$$

as the strength of the plate between the pitch lines on the middle row of rivets plus the shearing strength of one rivet in single shear on the outer row.

This style of joint may fail by breaking the plate between the outer row of rivets, by shearing all of the rivets or by breaking the plate along the middle row of rivets and shearing the outer row. The riveting now exceeds the strength of the solid plate, as will be seen by comparing quantities *A* and *C*. A more efficient joint would be secured by spacing the rivets farther apart. Quantity *B* being the smallest, the joint would probably fail by breaking the plate along the outer row of rivets. Therefore

$$\frac{B}{A} = \frac{151{,}800}{180{,}000} = 0.845 \text{ or } 84.5 \textit{ per cent.}$$

and the safe working pressure is

$$\frac{60{,}000 \times 0.5 \times 0.845}{30 \times 5} = 169 \textit{ lb.}$$

per sq.in.

So far, none of the joints considered have been of correct design for the case at hand, but they have served to demonstrate the methods of calculating their efficiencies and also by guessing at the efficiency may possibly lead to unsatisfactory results. A standard quadruple-riveted, double butt-strap joint will now be laid out, as shown in Fig. 8, with the following particulars:

Rivets, $\frac{15}{16}$ in. (after driving).
Pitch of outer row, 15 in.
Pitch of second row, 7½ in.
Pitch of two inner rows, 3¾ in.

$$A = P \times t \times T.S. = 15 \times 0.5 \times 60{,}000 = 450{,}000 \textit{ lb.}$$

the strength of the solid plate in a unit length (15 in.) of joint.

$$B = (P - d)\ t \times T.S. = (15 - 0.9375) \times 0.5 \times 60{,}000 = 421{,}875 \textit{ lb.}$$

the strength of plate between rivet holes on the outer row.

$$C = N\ S\ a + N'\ S'\ a = 3 \times 42{,}000 \times 0.6903 + (8 \times 78{,}000 \times 0.6903) = 86{,}977.8 + 430{,}747.2 = 517{,}725$$

the shearing strength of three rivets in single shear on the outer and second rows plus the shearing strength of eight rivets in double shear on the third and inner rows.

$$D = (P - 2d)\ t \times T.S. + N\ S\ a = (15 - 1.875) \times 0.5 \times 60{,}000 + (1 \times 42{,}000 \times 0.6903 = 393{,}750 + 28{,}992.6 = 422{,}742.6 \textit{ lb.}$$

representing the strength of plate between the rivet holes on the second row plus the shearing strength of one rivet in single shear on the outer row.

This joint will probably fail by breaking the plate along the line of the outer row of rivets, although the quantity *D* is but slightly greater than the quantity *B*. The efficiency of the joint is therefore

$$\frac{B}{A} = \frac{421{,}875}{450{,}000} = 0.9375 \text{ or } 93.75 \textit{ per cent.}$$

and the safe working pressure is

$$\frac{60{,}000 \times 0.5 \times 0.9375}{30 \times 5} = 187 \textit{ lb.}$$

per sq.in.

In the last two joints, failure would probably occur by breaking the plate along the line of the outer row of rivets. This is usually the case with properly designed joints, and from this fact may be derived a short rule for the efficiency of joints which may be useful if used with judgment. The rule is to simply divide the strength of the net section of the plate between the two rivet holes on the outer row by the strength of the solid plate in a unit length of joint; in other words, find quantity *A* and quantity *B* and divide the latter by the former.

Generating Power as a Byproduct

By Edward K. Hammond

In the plant of the M. Rumely Co., La Porte, Ind., an interesting method has been adopted for securing power as a byproduct which serves as a material aid to the output of the regular power plant.

The "oil pull" tractors manufactured by this company—which comprise self-contained power units especially designed for such agricultural pursuits as plowing, hulling and threshing—derive their power from kerosene, and after the completion of each machine, it is subjected to a test of at least 48 hours' duration before being shipped. During this test run, the expedient of belting the tractors to electric generators has been adopted so that the power developed may be utilized for industrial purposes.

The illustration shows a group of "oil pull" tractors running in the company's test shed and the method of arrangement is easily understood. The elevated platform running through the center of the shed has the electric generators so mounted upon it that 11 tractors may be tested on either side. Since the plant was placed in operation, there have been six or more of these tractors running under test at all times developing an average of between 180 and 200 kw. This output would, of course, be insufficient to meet the power requirements of the entire factory, but as it is obtained without any extra expense for fuel, it is the means of effecting a considerable saving.

The regular power plant at the Rumely works is essentially a Nordberg installation. The equipment consists of two 19 and 36 by 36-in. cross-compound units, equipped with the Nordberg patent long-range cutoff valve-gear. They are run condensing and are direct-connected to 500-kw. Fort Wayne direct-current generators running at 120 r.p.m. A 32 and 32 by 14-in. duplex steam-driven jet condenser provides for the exhaust from the engines and also for the operation of a 1500-cu.ft. compressor which supplies air to the tools in the shops at 100 lb. pressure. The boilers are in a separate building, the equipment consisting of a battery of six Atlas hand-fired boilers. Coal and ashes are handled by a C. W. Hunt industrial track and car equipment.

Traction Engines under Test

March Coal-land Values Reach $6,442,820

In its classification and valuation of public coal lands, the United States Geological Survey acted on 1,398,371 acres in March. Of these, 368,484 acres were appraised as "coal land" by 40-acre tracts, valued at $6,442,820. There were also classified as coal lands, but the price not fixed, 16,404 acres, while 401,668 acres were classified as "noncoal."

Restorations during the month of lands classified either as coal or noncoal amounted to 801,137 acres, and were distributed through Colorado, Montana, North Dakota, South Dakota and Utah. New withdrawals of 597,234 acres were made in Utah.

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

New Valve Affects Economy

The accompanying indicator diagrams were taken from the steam cylinder of a 12x14-in. air compressor using a throttling governor and fitted with a plain slide valve. The machine had been running about seven years and during this time had never been indicated. As the compressor was too small for the work required of it, and ran at very high speed, all the bearings seemed to pound

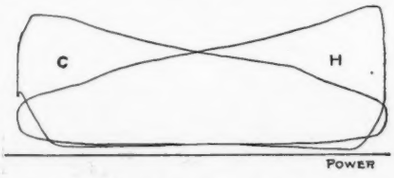


DIAGRAM FIG. 1

at once, although they were kept keyed up as closely as possible.

In an attempt to stop the noise, I decided to take some diagrams; Fig. 1 is a sample, and shows the point of cutoff to be at about three-quarters stroke and a terminal pressure of about 23 lb. I tried changing the eccentric, but while I could obtain an earlier cutoff, the compression was excessive, so I decided to make a new valve having an extra outside lap to give earlier cutoff. The exhaust lap could not be decreased as the exhaust cavity was as wide as it could be made and still prevent steam blowing through from the steam port to the exhaust port.

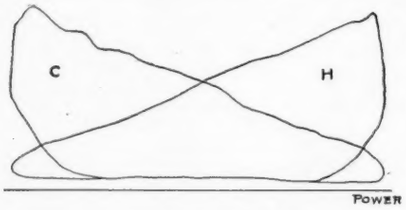


DIAGRAM FIG. 2

After the new valve was put in, diagram No. 2 was taken, which shows the cutoff to be about one-half stroke with a fairly good compression. The terminal pressure was about 12 lb., which was a great deal with the exhaust steam blowing to the atmosphere.

The bad pound in the bearings was gone and the machine ran as quietly as could be expected from an air compressor.

In figuring the reduction in coal consumption due to this change, the diagram, Fig. 1, figured 50.5 hp. and the steam consumption at 37 lb. per horsepower-hour.

Fig. 2, which was taken at a little higher speed, showed 55.6 hp. and the steam consumed was 33.2 lb. per horsepower-hour as calculated from the diagrams with allowance made for condensation, etc.

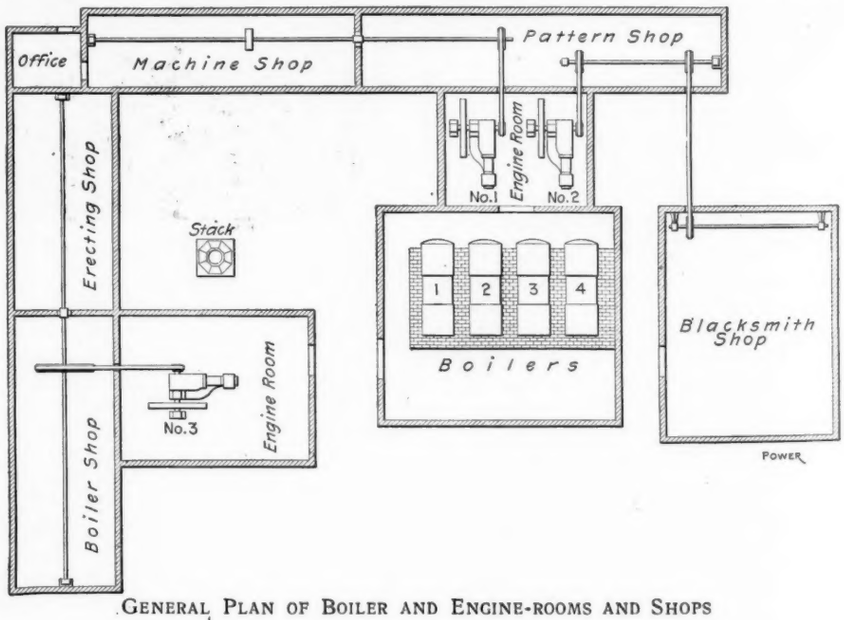
As the result of this change a saving of nearly $200 per year in fuel costs was realized, with the additional comfort of a better running engine.

J. C. HAWKINS.

Hyattsville, Md.

Ignored the Engineer's Advice

No. 1 engine, shown in the accompanying illustration, was giving trouble due to wear; it had been in service about 40 years. The engineer suggested installing an alternating-current generator direct-connected to No. 3 engine and operating the shops with motor drive, thus eliminating No. 1 engine. This was possible as the latter was used only intermittently and the load on No. 3 was much below its rated capacity.



GENERAL PLAN OF BOILER AND ENGINE-ROOMS AND SHOPS

The central-station solicitor knew the conditions in this plant and was successful in influencing the management to use central-station current to do the work of engine No. 1, quite contrary to the engineer's suggestion.

After this service had been used for a short time the management discovered that it was costing them $6 more per week for power than before the change was made. Complaints brought the central-station experts to view the situation, and they recommended the discharge of the assistant engineer, saying one man could handle the plant. As it was over 200 ft. from engine No. 3 to engine No. 2, it will be realized that one man could not properly attend to the plant. He is doing his best, but despite his efforts the cost of power to the concern increases rather than diminishes.

Such failures serve to show that the central station does not always meet its obligations.

W. V. FORD.

Norwich, Conn.

Knowledge Is Power

The lack of proper records is undoubtedly one of the chief reasons why so many isolated-power plants have been shut down and why others have not been installed. An engineer need never fear the closing down of his plant if he can prove it is a paying investment. The argument that the central-station solicitor will use the records to close down the plant is seldom tenable. In many cases they do not use the recorded data, but take advantage of the lack of it.

Sometimes it is very difficult to get complete records, as where they require instruments which the owner refuses to purchase. But if the engineer will record all data available and show the owner

their advantages, he will usually be able to get what he needs.

Furthermore, every chief engineer should make his engine room a training school for engineers. This is a point that cannot be too strongly emphasized. The successful business men of today are those who have been able to get efficient work out of their employees, and the only way to do this is to have the employee know the "how and why" of his occupation.

The day of trade secrets is past. Engineers should get over the jealousy that seems to exist between themselves, and be free to ask and answer questions.

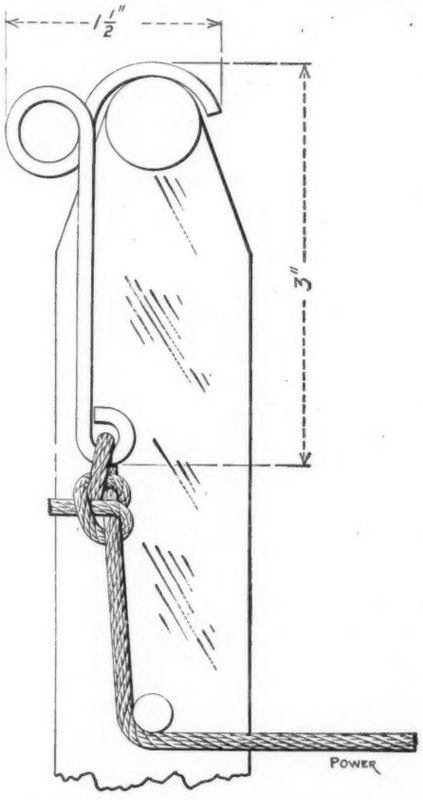
I would like to see published in POWER more copies of engineers' records.

C. L. JOHNSON.

Newark, N. J.

Drum Cord Attachment

The plain hook shown in the accompanying illustration is the simplest and most satisfactory attachment for the drum cord of a steam-engine indicator in high-speed work I have ever known. This is made from a piece of soft steel wire



SHOWING ATTACHMENT OF REDUCING LOOP

of about No. 13 gage. The hook starts out with a comparatively shallow curve, for convenience in applying. At the back of the jaws a 3/8-in. handle is looped in, and the wire then runs straight down and terminates with a suitable eye bent over at the end. The completed overall dimensions of the hook are about 1½x3 in.

The illustration shows the hook in operation, hanging on the pivot of the pendulum blade, with the cord running down under a pin or screw on the pendulum and then leading over to the indicator itself. This blade pin is located between the crosshead and the pivot of the pendulum, in a position giving the desired reduction of motion. To adjust the length of the cord, place the hook and cord as shown, with the string passing unfastened through the eye, and gradually tighten the string until the indicator drum safely clears all stops; then fasten the cord with a tight double half-hitch.

This attachment is operated entirely by one hand. To hook up the indicator, grasp the "loop" or handle of the hook between the thumb and index finger; draw the cord out taut and under the pin of the pendulum, then swing the hand upward and hook over the pendulum pivot, or upon a second pin of the blade near the pivot, as shown. To unhook, the reverse operation is gone through and the cord is hung out of the way, yet conveniently, by hooking over the pivot from the other side, with the string hanging free.

The actual operation is quickly done and can be performed with ease under the most trying conditions of running.

J. W. TAYLOR.

Massillon, Ohio.

The V-Thread on the Bolt

I have a great admiration for the genius who first conceived the idea of the thread on a bolt, but can the conditions be improved? Many a man has tried to make a half-inch nut with a 12-pitch thread affiliate with a 13-thread bolt, or *vice versa*. It started beautifully, and then it put on the brakes; he pulled harder; then he pulled too hard. Next, he got another wrench, and stuck a chisel in behind the head of the bolt to keep it from turning. On reversing the nut, some of the thread on the bolt was stripped off; then he had to hunt another bolt or the dies.

V-thread bolts, nuts, taps or dies, set-screws and cap-screws are things of the past. U. S. Standard thread eliminates the half-by-twelve thread, and lets the $\frac{9}{16}$-in. size have it, which is perfectly fair and proper. The $\frac{9}{16}$-in. is a good honest size, which has never been appreciated, but should be, by having a thread of its own.

The manufacturers have decided not to make any more V-thread taps and dies except by special order, but in a number of catalogs I find listed the V-thread bolts and nuts and it must be specified if the other is wanted.

The U. S. Standard thread will also eliminate the $\frac{1}{32}$-in. oversize bolt that has been such an enemy all this time.

When this matter is fully straightened out, it is my opinion that the nut manufacturers should be made to standardize the nuts; then a lot of capital will not be tied up in dozens of different-sized wrenches in orded to meet existing conditions.

L. F. BROWN.

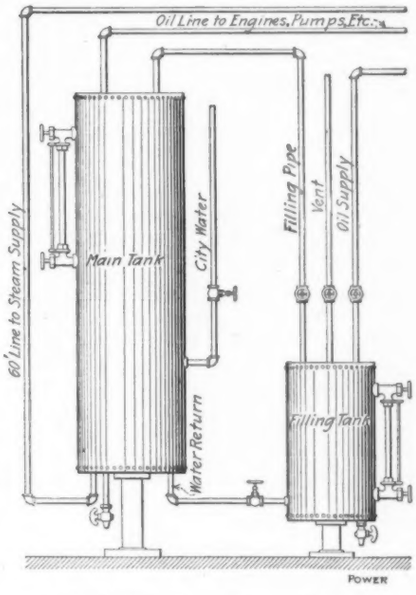
Winston-Salem, N. C.

Remodeled Oiling System

In our plant there is an oiling system designed as shown in the accompanying illustration.

It had been installed with the plant some ten years ago, but had never been put in operation until a short time ago, when we made some changes in the piping and method of operation. The result is very gratifying.

At the opening marked "city water" in the illustration, now used only as a



ARRANGEMENT OF OILING SYSTEM

filler, a ¾-in. steam line not over 5 ft. long was connected and was the only provision for the admission of live steam; it is very evident that there was not much chance for condensation in such a line.

A ⅜-in. line was run from a steam supply at the far end of the engine room and connected to the bottom of the tank, and a small tank was rigged up as a filler and connected to the oil tank by the top and bottom connections with the valves. The small tank was connected with the oil-supply room with a provision for filling it by gravity after being emptied of water.

There is no trouble with the system now, care being taken to keep the large tank full and cool at all times, and considerable saving has been effected, to say nothing of the added convenience by the use of the remodeled system.

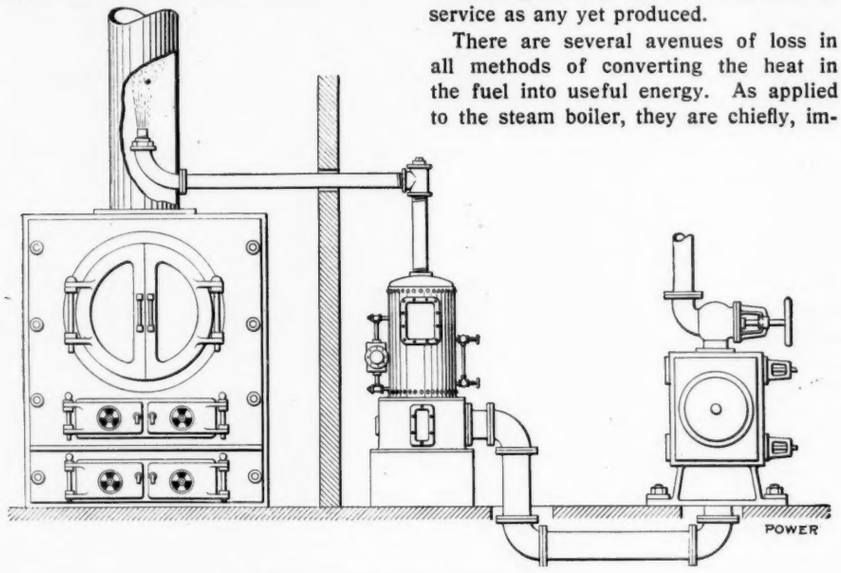
EDWARD T. BINNS.

Philadelphia, Penn.

Avoiding a Shutdown

During a high wind, the smokestack of a small flour mill was blown down, leaving a piece at the base about 14 ft. high still standing.

As this mill was in a small country town, it would take at least a week to get a new stack, so it was up to the engineer to figure out a way to keep the mill going until the new stack arrived. He was experienced in traction engines, so it did not take him long to think of the scheme shown in the illustration. He piped the exhaust steam from the engine into the base of the stack and placed an elbow on the end of the pipe so as to discharge the steam straight up the center of the stack, and screwed a bushing into this elbow in order to increase the draft. Of course, this put considerable back pressure on the engine, but it kept the plant running.



EXHAUST STEAM ASSISTING DRAFT

CHARLES FENWICK.

Wapella, Can.

Return-Tubular Boilers

In selecting a steam generator, if floor space, head room or other limitations which make imperative the use of any one type are not imposed, there are few definite data of performance for guidance beyond the many claims of those interested either in manufacture or sale, or possibly others who wish to justify their particular choice. These conditions cause many purchasers to rely upon the reputation of the builder and to follow to a large extent the suggestions as to installation and appurtenances that tend to surround the tests and operation with the most favorable conditions.

These circumstances have led, through the efforts of the builders, to the favorable reputation attained by the water-tube boiler throughout the engineering world. That wonderful results in economy and performance have been accomplished with this type cannot be denied. In view of the foregoing, the general tendency has been to credit water-tube boilers with being in advance of the other and more common forms, especially the horizontal tubular boiler. This, however, is not altogether borne out by the facts. As developed today in the United States and built by the hundreds of reputable manufacturers, the horizontal tubular boiler, equipped with the same appliances and settings usually afforded the other type, is equally as reliable and efficient a steam generator for certain classes of service as any yet produced.

There are several avenues of loss in all methods of converting the heat in the fuel into useful energy. As applied to the steam boiler, they are chiefly, imperfect combustion, imperfect transmission of the heat units to the water, and radiation from the settings and furnace walls. The first of these losses is corrected by proper firing and furnace arrangement, until a minimum is reached that is possible in one type as much as in another. The second loss, evinced by high stack temperature, is common to all types. The final temperature of the gases upon leaving the boiler must necessarily be in excess of that of the steam and water contents, and to make this temperature a minimum is the aim of all good engineers. The many divisions in which the products of combustion pass through the tubes of the horizontal tubular boiler form an admirable means of giving up the heat contents to the surrounding water. The final heat loss in this, as well as other types, is usually modified by the use of economizers or other preheating apparatus. As the loss by radiation from the walls, settings and exposed portions of the shells or drums is common to all, no comparison is needed.

In stability of operation, the odds are mainly in favor of the tubular type; the large body of water at a high temperature will continue the regular generation of steam over short periods of imperfect or irregular firing or sudden fluctuations in steam demand in a manner possible only in a generator of large water capacity.

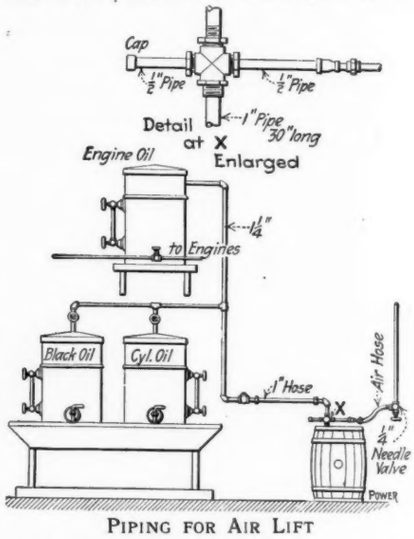
One of the broadest and most frequent claims made by those favoring the water-tube type is its immunity from disastrous accident as compared with boilers of the shell type. Records do not entirely corroborate this, however, for many serious tube failures have occurred in water-tube boilers. Furthermore, it must be remembered that failures of shell boilers have led to a development of construction in which many of the older weaknesses have been eliminated. Among these are improvements in seam efficiency, weldless braces, increased accessibility for cleaning purposes and better structural materials, and the evolution in these appears to have kept pace with present-day requirements.

W. J. SMITH.

Portland, Ore.

Compressed Air Oil Lift

In any factory or mill where compressed air is available and there is a considerable amount of oil or other liquids to be taken from barrels and transferred to tanks or other receptacles, the device shown herewith will make a very useful adjunct to the engine room.



PIPING FOR AIR LIFT

It is simple in construction and can be made in a short time (with the exception of a special bushing, which requires lathe work) by anyone familiar with pipe tools. The accompanying sketch shows the construction plainly, also the method of using the device in our power plant.

Care should be taken not to open the air valve too suddenly, especially when pumping cylinder oil, which is generally heavy and hard to move. It is best to let the cylinder oil stand in a warm place for a day or two before attempting to pump it out. A ¼-in. needle-valve on the air line should be used, but an ordinary valve will do if the attendant is careful.

A. R. MUNZER.

Middletown, Ohio.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Pump Diagrams

The efficiency of the pumping plant described by Frank Willis in the Feb. 20 issue is so low that there must be some user of steam other than the compound duplex pump from which the diagrams were taken.

The capacity of the water cylinders of the pump, at a pumping speed of 33 strokes per minute, neglecting slippage, is

$$\frac{6\frac{1}{2}^2 \times 0.785 \times 22\frac{1}{2}}{1728} \times 2 \times 33 \times 60 = 1710 \text{ cu.ft.}$$

per hour. The average pressure pumped against is 350 lb. per square inch, or 50,400 lb. per square foot. Hence the work done is

$$1710 \times 50{,}400 = 86{,}184{,}000 \text{ ft.-lb.}$$

per hour, which is equivalent to 43.5 hp.

The oil burned as fuel averages 63 gal. per hour. Since oil of 15.6 deg. Baumé weighs 8.01 lb. per gallon, the weight of the oil used is 504.6 lb. per hour. Assuming that the oil has a heat value of 18,500 B.t.u. per pound, the heat supplied to the boilers is

$$504.6 \times 18{,}500 = 9{,}335{,}100 \text{ B.t.u.}$$

per hour; hence the mechanical equivalent of the heat supplied in the oil is

$$778 \times 9{,}335{,}100 = 7{,}262{,}708{,}000 \text{ ft.-lb.}$$

per hour. Thus the overall efficiency of the plant is

$$\frac{86{,}184{,}000}{7{,}262{,}708{,}000} = 1.18 \text{ per cent.}$$

Expressed in other terms, the duty of the plant is

$$\frac{86{,}184{,}000}{9.335} = 9{,}232{,}200 \text{ ft.-lb.}$$

per 1,000,000 B.t.u. supplied in the fuel. Prof. Denton, in testing the Laketon pumping engine (*Trans.*, A. S. M. E., Vol. 14), using oil as fuel under the boilers, obtained a duty of 101,117,000 ft.-lb. per 1,000,000 B.t.u., corresponding to a plant efficiency of 13 per cent. Thus, even after making allowance for differences between actual running and test conditions, Mr. Willis' plant shows a low efficiency.

A calculation of the diagrams given shows that the work done in the high-pressure steam cylinder is 22.2 hp., and in the low-pressure cylinders 36 hp., a total of 58.2 hp. Thus the mechanical efficiency of the pump is

$$\frac{43.5}{58.2} = 74.7 \text{ per cent.}$$

The steam consumption of the pump can be calculated from the displacement of the high-pressure steam cylinders, since the diagram shows that steam is admitted throughout the entire stroke at a pressure of about 45 lb. per square inch. This displacement is

$$\frac{16^2 \times 0.785 \times 22\frac{1}{2}}{1728} \times 2 \times 33 = 172.8 \text{ cu.ft.}$$

per minute. Since steam at 45 lb. pressure weighs 0.139 lb. per cubic foot the steam used is

$$172.8 \times 0.139 \times 60 = 1440 \text{ lb.}$$

per hour. Assuming that 10 per cent. of the steam furnished is lost in condensation, leakage, etc., the amount of steam furnished is

$$1440 \div 0.90 = 1600 \text{ lb.}$$

per hour. The work done by the pump, as shown above, is 86,184,000 ft.lb. per hour, so the duty of the pump alone is

$$86{,}184{,}000 \div 1.6 = 53{,}865{,}000 \text{ ft.-lb.}$$

per 1000 lb. of steam.

As the duty of a pump similar to the one under consideration installed by the Boston water department was 60,727,400 ft.-lb. per 1000 lb. of steam under test, it is evident that the pump is not responsible for the low efficiency of this plant. The cause of its inefficient operation must therefore be an incorrect arrangement of the oil burners or an excessive steam consumption of the auxiliaries.

C. S. STOUFFER.

Kewanee, Ill.

The Critic Criticized

As one of a large number of people who have found Moyer's "Power Plant Testing" a valuable book, I feel compelled to protest mildly against the statements made in your review of Mar. 19.

Latterly, POWER has done much to improve its book reviews, and there is less reason for complaint against them than against those in many other technical papers, where they are often nothing more than a digest of the author's preface.

Prof. Moyer's book, it seems to me, is admirably adapted to the purpose for which it was written; namely, a college textbook, and, furthermore, it has been a very useful book to a lot of practicing engineers whom I know.

The reviewer was not only very sharp in his phraseology but somewhat inaccurate in his statements; he also gave no apparent consideration to the purpose of the book. Naturally, no one would expect, or even tolerate, very much absolutely original subject-matter in a book intended to cover concisely so large a subject. A far more just criticism would have been to say that the author was blowing his "horn" a little too hard for himself and his professional friends. Furthermore, the book certainly would not have been complete without the digest of the standard American methods for testing boilers, engines, turbines and pumps.

Unless the reviewer referred merely to "style" in the presentation of the subject-matter, I see nothing at all in his argument; and, as to matters of "style," we could argue till doomsday, and arrive nowhere.

If the work had "smacked of originality" or met in any way the reviewer's ideas as outlined in the first paragraph, it would utterly fail in its usefulness as a college textbook.

The reviewer is certainly mistaken also when he states in effect that the subjects "belong in the usual list found in books on experimental engineering." The writer is familiar with the books in English on this subject and he is quite sure that at least one-third of the subject-matter will not be found in any other book on "experimental engineering" published before the appearance of Moyer's "Power Plant Testing"; and, on the other hand, practically all of this matter is covered in about the same number of pages in all books published more recently on this general subject.

Criticisms regarding the illustrations also are, in some respects, unjust, as the writer can see that the publishers must have gone to very great expense to make new figures for many kinds of apparatus that are purely commercial, apparently to avoid the "stock" criticism of reviewers of technical books that "the figures are mostly from trade catalogs." It is true that some of the figures are conventional of textbooks; but in every case, apparently, proper credit has been given.

As to whether the reviewer has "seen many of the figures in government reports," I believe he is mistaken. The writer has, of course, observed figures illustrating such standard commercial apparatus as separating steam calorimeters and Atwood's and Junkers' fuel calorimeters in such reports; but those in Moyer's book, in my opinion, are about as much different as it was permissible

to make them and still illustrate correctly their commercial forms.

Does POWER deem it necessary to sacrifice accuracy of statements to make a review "breezy"?

POWER's plans for book reviews are excellent. I am only "kicking" about what they should not be—about the kind that makes no attempt to find out what the author was trying to do, and then "roasts" a book for what it is not.

R. E. SMITH.

New York City.

Centrifugal Pump Troubles

I do not see that the distribution of the pumps in Milton Baker's pump problem, in the Mar. 26 issue, is at all necessary. The pipe line and pumps together form a closed conduit from the lower to the upper water levels; therefore the amount of head or pressure developed by each pump depends upon the speed and design of its propeller and not on its location in the line.

The three pumps should be placed together near the lower level to avoid further trouble. This would increase the pressure on the pipe just above the pumps, but would do no harm.

If it is not considered practicable to move the upper pumps, it might be possible to operate them without mishap if the following precautions are observed:

Place a bypass around each check valve except the one on the suction to the lower pump, and see that the column of water is solid before starting the pumps. Then start the tower pump first, adjusting it so that it will run at full speed as soon as the others start. It will probably not move any water with the full 70-ft. head against it, but it will develop sufficient pressure to hold the column of water together and start the flow when the other pumps start. Then start the middle pump in the same manner and lastly the upper pump.

When shutting down the order should be reversed, stopping the upper pump first. All this is based on the assumption that they are protected by speed governors. If they are run "by the throttle," the lower pump will be apt to develop a dangerous speed when the others are shut down.

By following this plan the only chance for trouble that I can see is in case one of the lower pumps stops running from some accident. If this should happen, the other pumps should be shut down at once and the columns of water brought safely together by opening the bypasses around the upper check valves.

Mr. Baker says they are contemplating placing air chambers at the discharge of the pumps. I would suggest that they call in an expert in this matter; the conditions warrant it.

FRED BOONE.

Davidson, Okla.

Mr. Baker's plan of placing air chambers at the discharge of the pumps to cut down the jar due to the making and breaking of the column of water in the line, will no doubt help conditions materially, but why not have a means of starting all the pumps simultaneously? He does not name the type of motive power for the pumps, but a satisfactory starting device could be arranged with either steam or electric drive.

R. G. COX.

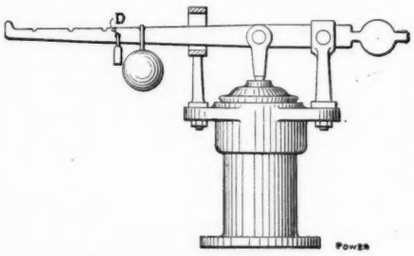
Milwaukee, Wis.

Valve Locking Devices

I quite agree with John Thorn as to his statement in the Mar. 12 issue of the importance of locking many valves.

At a plant where I was employed the native labor would persist in moving the weight on the lever of the air-compressor safety valve, causing no end of trouble.

To avoid all this I locked the weight as shown in the accompanying illustration. I bored a hole in the valve lever



A LOCKED SAFETY-VALVE

as shown at *D* and inserted a padlock in it. This prevented the weight being moved any appreciable distance. The job was completed in a short time and my mind put at ease, as the valve was located outside the building and consequently out of my sight.

B. W. BARRENO.

San Luis Potosi, Mex.

Central Station vs. Isolated Plant

V. S. Ball's article under the above heading in the Apr. 9 issue gives the other side of the question, but all will not agree with him.

Of course, there are plants running under conditions where the central station could give better service, but where there is a plant running 12 months a year and the central station can sell it power cheaper than the plant can make it, some fault is to be found either with the engineer or his employer.

In his example of a case where the central station could save a company money, Mr. Ball relates a case where a concern keeps an engineer running part of the plant until midnight to light an electric sign.

If the chief engineer of this plant was a "live one," he would have a storage battery to run that sign; he would save fuel and the engineer's wages.

There are very few employers, in my opinion, who will not listen to an engineer's suggestion for saving money if it sounds reasonable. Mr. Ball tells of another case where an engineer got a better job through letting the central station take his plant away from him. I do not think that a man who knows much about engineering will be content to let a central station get his plant.

Most "live" engineers work for something besides the pay envelope; most of them are looking for more experience and bigger plants, and I cannot see why a man could be contented just oiling shafting and running a heating boiler, as Mr. Ball said he would. It seems to me that a man who is satisfied with such conditions is either a starter and stopper or a has-been.

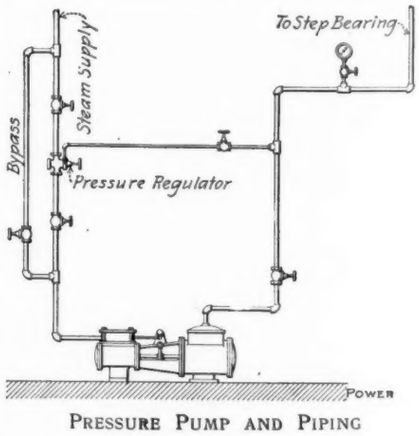
L. W. CHADWICK.

Bridgewater, Mass.

Oil Pipe Leaked

Luke Marier's letter of the Mar. 19 issue mentions that the oil pressure in the discharge line from the pump supplying the step bearing on the turbine varies with the boiler pressure, and that when the steam pressure drops the pump slows down, allowing the oil pressure to drop also, which, as he states, is dangerous practice for that type of turbine.

I believe if he will connect up his pump as shown in the accompanying sketch, he will overcome the trouble. It will be seen that a pressure regulator is used in the steam-supply line and connected to the pump-discharge line in the usual manner; also that the steam



PRESSURE PUMP AND PIPING

is bypassed around the regulator in such a manner as to permit repairs to be made, should they ever become necessary while the pump is in operation.

With this arrangement, should the steam pressure drop enough to slow down the pump and cause a drop in pressure in the oil line, the regulator would at once open up, allowing more steam to flow into the pump and maintain sufficient pump speed to hold the oil pres-

sure at the required point; then as the steam pressure increases again the oil pressure will also increase. The oil pressure will act on the regulator, thereby decreasing the amount of steam flowing to the pump and preventing the oil pressure from going higher than the determined point. A good regulator can be made to regulate very closely and maintain practically constant pressure under varying steam-pressure conditions.

THOMAS BAKER.

New York City.

Automatic vs. Fixed Cutoff for Compound Engines

In the Mar. 5 issue, William E. Francis has a letter relating to a pumping engine. He refers to the governor controlling the cutoff on the high-pressure cylinder, "while the cutoff for the low-pressure cylinder was regulated by hand."

This brings to mind some inquiries I made some time ago relating to automatic and fixed (hand-regulated) cutoffs for low-pressure cylinders of compound engines. The questions were these: "What is the idea of a fixed cutoff on the low-pressure cylinder of a compound engine? Under what conditions would it be desirable to use the fixed cutoff instead of that which is controlled by the governor?" Desiring to learn as much as possible concerning the matter, I wrote to several makers of compound engines for information, and it was courteously given.

One firm stated that the cutoff on all its compound engines is controlled by the governor. Fixed cutoff for the low-pressure cylinder was ordered for the purpose of throwing more load on the high-pressure cylinder when running light, thereby raising the receiver pressure. This would prevent the formation of a vacuum in the receiver and allow no water into the low-pressure cylinder.

Another company claims that a governor-controlled cutoff for both high- and low-pressure cylinders maintains a constant receiver pressure, the power in the cylinders being varied by the variable cutoff. This construction, it is claimed, is particularly adapted to 60-cycle electrical generation as "it reduces to a minimum the tendency to increase or decrease the engine from uniform rotation." This company uses the fixed cutoff on compound- and triple-expansion pumping engines.

Another concern claims that the fixed cutoff is less expensive to make and can be used advantageously on engines running under uniform load, such as pumps and air compressors.

One firm sees no advantage in a fixed cutoff, but claims that poor regulation results from its use. It infers that a fixed cutoff is dangerous on account of the possibility of excessive speeds being attained if the main belt should break or the circuit-breaker blow out.

CHARLES J. MASON.

Scranton, Penn.

A Pumping Problem

William Bettis' letter in the issue of Mar. 12 is very misleading in regard to the action of centrifugal pumps. He is correct in figuring that the water would rise to a height of 14 ft. when there was no flow, but when water is being delivered the result is very different and the pressure head developed may be far from $V^2 \div 2g$. In fact, it is well known that many centrifugal pumps will pump water to a height greater than they will raise it when there is no water flowing. For instance, the pump Mr. Bettis illustrates would probably deliver water to a height of 15 ft. if it once got started. This would be impossible if his statement that "14 ft. would then be the total head that the pump was capable of at the given speed" was true. He should apply Bernoulli's theorem for flow though a rotating casing instead of the theorem for flow through stationary pipes.

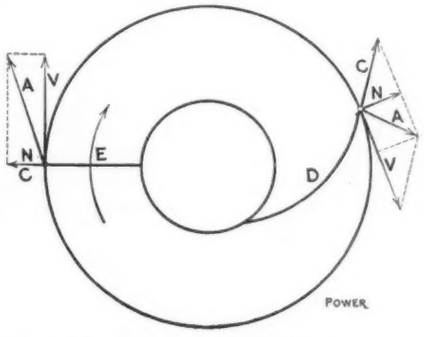


DIAGRAM TO ILLUSTRATE BERNOUILLI'S THEOREM

The accompanying illustration shows more nearly what actually is taking place. This represents the runner of a centrifugal pump; D is a vane having a backward rake and E is a radial vane. Let V represent the velocity of the tip of the impeller, C the velocity of the water relative to the impeller and N the normal component of the velocity of the water as it leaves the impeller. Then A will be the real or absolute velocity of the water as it leaves the impeller. When the vanes are radial, N and C coincide.

When no water is flowing, C is zero and A is equal to V and the pressure head is equal to $V^2 \div 2g$ as Mr. Bettis figures. But the water also has a velocity head equal to $V^2 \div 2g$, making the total head at the tip of the impeller equal to $V^2 \div g$, or twice the maximum head that Mr. Bettis figured. Since he figured the velocity head at the end of the pipe, he should not neglect the velocity head at the tip of the impeller.

When water is flowing, the pressure head at the tip of the impeller, according to Bernoulli's theorem, is $(V^2 - C^2) \div 2g$. In other words, the runner still develops a pressure head of $V^2 \div 2g$, but $C^2 \div 2g$ is used to give the water the relative velocity C; this leaves $(V^2 - C^2) \div 2g$ as the pressure head at the tip of the impeller. Since C is larger with vanes like D than with those like E, radial vanes give a higher pressure than curved vanes when the speed and volume pumped are the same. In addition to the pressure head at the tip of the impeller, the water has a velocity head of $A^2 \div 2g$. This velocity head can be converted into pressure by stopping the water without shock. Therefore the total head at the tip of the impeller is $(V^2 + A^2 - C^2) \div 2g$; $(V^2 - C^2) \div 2g$ equals the pressure head and $A^2 \div 2g$ equals the velocity head. With radial vaned pumps $(A^2 - C^2)$ is equal to V^2 and $(V^2 + A^2 - C^2) \div 2g$ is equal to $V^2 \div g$. With vanes having a backward rake $(V^2 + A^2 - C^2) \div g$ is less than V^2 and with vanes having a forward rake $(V^2 + A^2 - C^2)$ is greater than V^2.

In order to prevent shock, it is necessary to reduce the velocity A gradually, and this is the purpose of the volute and of the guide vanes in the diffuser of turbine pumps. It is evident that $A^2 \div 2g$ is greater with radial vanes than with curved vanes with the same speed and rate of flow; consequently the loss with D is less if the volute or diffuser is poorly designed. When centrifugal pumps were first made they had radial vanes, but Appold found that vanes like D gave much higher efficiencies. This was because the pumps had no diffusers and poorly designed volutes; hence $A^2 \div 2g$ was lost. By careful design, pumps can now be made with radial vanes that give as high efficiencies as those with curved vanes.

From the figure it is also evident why a pump with radial vanes would overload worse than one having curved vanes. The volume pumped is proportional to N, while the pressure at the tip of the impeller is $(V^2 - C^2) \div 2g$. Now with curved vanes, if N increases, C increases much more and $(V^2 - C^2)$, the pressure, takes a heavy drop. With radial vanes, if N increases, C is increased by the same amount and the drop in pressure is not so great as with curved vanes; in other words, a given drop in head causes a much larger increase in volume with radial vanes than with curved vanes.

In this discussion, losses by friction and shock are neglected and the velocity of the water, at the entrance to the pump, is assumed to be zero.

GEORGE L. SULLIVAN.

Bozeman, Mont.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Lead Required for a Slide Valve Engine

What lead is required for a 5x7-in. slide-valve engine?

D. J.

It is customary to set the valve so that a knife blade can be inserted between the edge of the valve and that of the port, when the engine is on dead center. All that is necessary is to admit steam quickly, so that the admission line of the diagram will not incline inward.

Longitudinal Seams

Why are the longitudinal seams of a boiler made double or stronger than the circumferential seams?

B. H.

The force tending to pull a boiler apart endwise is the pressure acting upon the area of the head. The metal resisting this is the product of the circumference and the thickness. The force tending to burst a ring 1 in. long is the product of the pressure per square inch and the diameter, and the area of the metal resisting it is, since the length is unity, the product of the thickness by 2. The force on each inch of circumferential seam is proportional to

$$\frac{\frac{Pressure \times diam.^2 \times 3.1416}{4}}{Thickness\ of\ sheet \times diam. \times 3.1416} = \frac{pressure \times diam.}{4 \times thickness}$$

and the stress on each inch in length of the boiler is proportional to

$$\frac{Pressure \times diam.}{2 \times thickness}$$

It is plain that, whatever the diameter, the stress on the longitudinal seams per unit of section will be twice that on the circumferential seams.

Range of Cutoff of Corliss Engines

Will the valves remain hooked and the steam follow full stroke, in a double-eccentric long-range cutoff Corliss engine when the engine is running slow?

R. C.

In any Corliss engine running below speed, if the safety cams do not prevent the valves from hooking on, the steam valves will remain open the entire stroke or until shut off by the lap, providing the speed is reduced to such an extent that the detaching mechanism does not release.

On either a single- or double-eccentric engine the cutoff cannot happen after the eccentric passes the center. On a double-eccentric engine the angular advance is less so the eccentric will not pass so early in the stroke.

Slide Valves and Diagrams

Suppose a slide valve cuts off at three-quarters stroke and a five-eighths cutoff is desired, what is the procedure? How is the proper length of an indicator diagram determined for any stroke and how is the proper bushing for the reducing wheel to be found?

F. W.

Advance the eccentric; this will also cause the engine to take steam earlier and release the exhaust and close it earlier. To preserve the same lead, add lap to the valve.

No particular length of diagram is imperative, but for purposes of analysis and measurement it is generally desirable to obtain the longest diagram consistent with good operation of the indicator. Diagrams from high-speed engines—i.e., making 200 r.p.m. and upward—are usually taken only 2 to 3 in. long, so as to reduce the error due to the inertia of the indicator paper drum. For slower speeds, most patterns of indicators are adapted for taking diagrams 1½x3 in.

Manufacturers of reducing wheels usually stamp figures on the edge of each shell or bushing to signify the length of the engine stroke for which the bushing is suitable. Of course, a bushing may be used with any shorter stroke of engine, provided the length of the diagram is satisfactory to the operator. The best manner of finding the proper size of bushing is to hitch up the reducing motion to the indicator with any medium-size bushing, and with a blank card on the paper drum and pencil lightly pressed against the card, draw out the main indicator cord by hand, until the pencil has marked off a line whose length is equal to the desired length of the diagram. In order to find the size of the bushing required for the same length of diagram for any stroke of engine, multiply the outside diameter of the trial bushing in inches by the length of the cord in inches which had to be drawn out by hand, and divide by the stroke of the engine in inches. The quotient will be the outside diameter of the bushing required to produce the length of diagram desired. As the length of the diagram need not be exact, the diameter of the bushing need be only approximately the size estimated, but it is always desirable to obtain the travel of the paper drum that will produce a diagram about 1 in. shorter than the maximum travel of the drum, so as to leave a margin for adjusting the length of the cord.

Effect of Increased Circumference

Assuming the earth to be 25,000 miles in circumference and to be surrounded by a tight-fitting steel band, how far from the earth would the band be, if the band were cut and 30 ft. inserted?

A. F. F.

The increase in the diameter would be 30 divided by 3.14159, regardless of the original diameter. The original diameter is

$$\frac{Circumference}{3.145159}$$

and the new diameter

$$\frac{Circumference + 30}{3.14159}$$

Therefore, the difference will be

$$\frac{30}{3.14159} = 9.55\ ft.$$

whatever the original diameter. The band will be raised above the earth half this distance, or 4.77 ft.

Equalizing the Work Done by a Cross-Compound Engine

How can the work done by the high- and low-pressure cylinders of a cross-compound engine be adjusted?

A. D. J.

By changing the cutoff in the low-pressure cylinder. The earlier the low-pressure cutoff the higher will be the receiver pressure, i.e., the greater will be the back pressure in the high-pressure cylinder and the initial pressure in the low-pressure cylinder, which will have the effect of reducing the work done in the high-pressure cylinder and increasing that done in the low-pressure cylinder.

The Bristol Recording Water Level Gage

The Bristol Co., of Waterbury, Conn., has recently put upon the market a gage for indicating and recording the depth of liquid in a tank or stream. A bronze casing provided with a very flexible diaphragm or membrane free from tension due to the elasticity of the rubber from which it is made, is submerged in the liquid, the depth of which is to be measured as shown in Fig. 1. The space above the diaphragm is air- and water-tight and the pressure of the air confined in it is directly proportional to the head of liquid acting upon the under side of the diaphragm. It remains only to convey this pressure to a recording gage

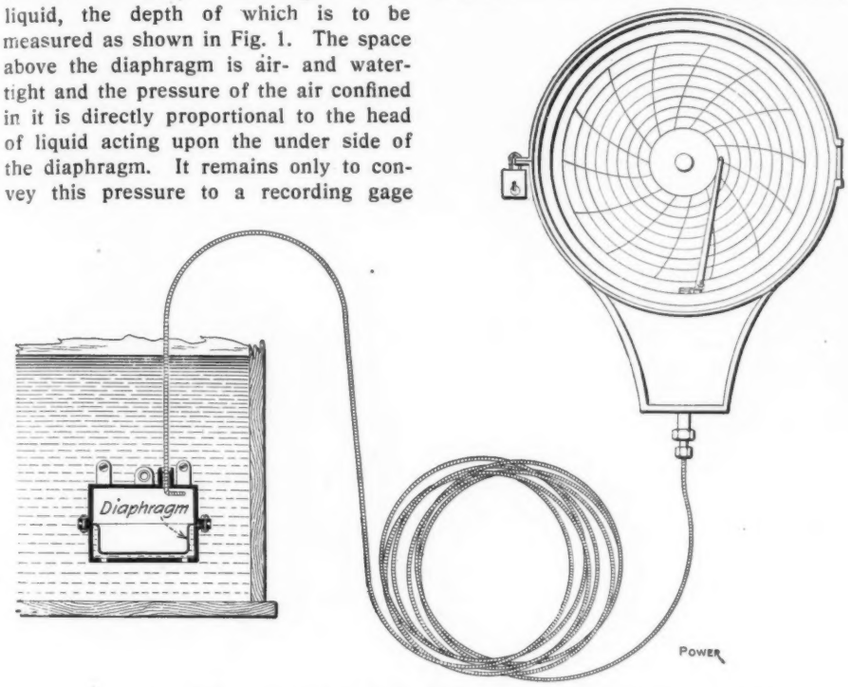


FIG. 1. SENSITIVE BULB CONNECTED TO A RECORDING INSTRUMENT

of sufficient sensitiveness to accomplish the object sought.

The instrument is so set that when the liquid is at the minimum level the pressure tube of the recording instrument is subject on the inside and outside to atmospheric pressure only. The indication is not affected by the relative

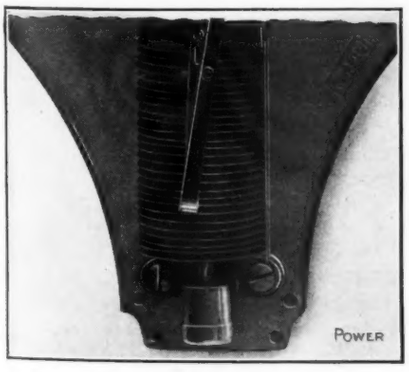


FIG. 2. FLEXIBLE DIAPHRAGM OF RECORDING INSTRUMENT

level of the gage and the liquid, so that the gage may be placed above as well as below the tank and at any reasonable distance. By applying the gage to the measurement of the depth of liquid flowing over the sill of a weir or through an orifice, the quantity of water flowing may be determined and the gage calibrated to read in these quantities.

As no float is used and the exposed portion of the apparatus is submerged, it is not subject to derangement by floating ice and is independent of temperature, for the pressure is transmitted by a column of air and there is nothing to freeze. In cases where conditions require, as in a rapidly flowing stream, where it might be interfered with by the flow, the submerged casting may be protected by placing it inside a perforated case or barrel.

The variation in pressure with water is only about ½ oz. for each inch in head. To record this slight difference upon the large scale the same delicate

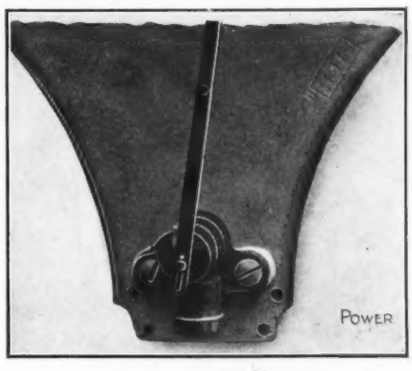


FIG. 3. SPIRAL TUBE OF RECORDING INSTRUMENT

apparatus is used which enables the aneroid barometer to indicate the difference in atmospheric pressure between the table and the floor level. This consists of a series of very flexible diaphragms shown in Fig. 2. Each of the several diaphragms is inflated and the aggregate movement of the series is available for transmission to the recording arm. This form of pressure tube is usually employed for ranges under 12 ft. and the record may be had upon any scale which will allow the total variation to come within the range of the chart. For higher ranges where a greater actuating force

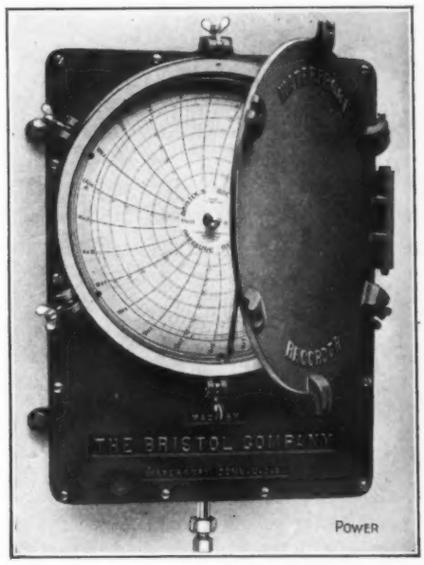


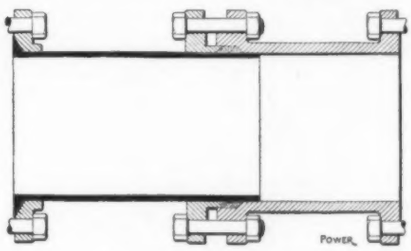
FIG. 4. MOISTURE PROOF CASING

is available, a spiral tube, Fig. 3, is used.

If a recording instrument is to be installed in an exposed position, the moisture-proof case, shown in Fig. 4, is available, while for inside use the ordinary form, shown in Fig. 1, will naturally be used.

P-K Expansion Joint

In this expansion joint the sleeve flange is made of cast iron and faces against the beveled surface of a boss cast on the end of a brass sleeve. The shell in which the sleeve fits is made of cast iron. Triple metallic packing, consisting of three triangular sections, the composition being



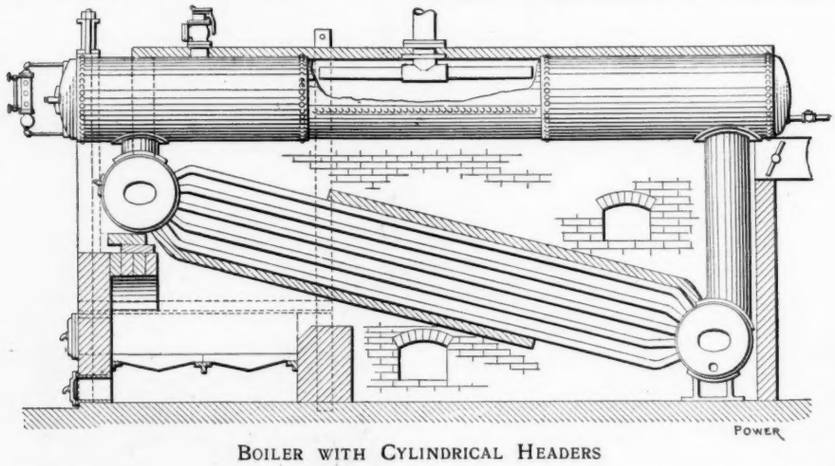
P. K. EXPANSION JOINT

determined by the pressure and temperature under which it works, is used when the joint is for steam. Rings of special hydraulic packing, composed of rubber and heavy duck, are used for water service.

This joint is manufactured by the P-K Engineer, 1309 Syndicate Trust Building, Tenth and Olive Sts., St. Louis, Mo.

Cylindrical Header Boiler

The boiler shown in the accompanying figure has been designed for use where headroom is limited. It is built in units up to 150 hp., with five rows of 3½-in. tubes expanded into cylindrical headers, front and rear. These headers are connected to a steam and water drum of suitable proportions, as shown.



BOILER WITH CYLINDRICAL HEADERS

Boilers of larger size are designed with two or more sections, one above the other, each five tubes high. No stayed surfaces are used in any part of the boiler and all parts are cylindrical.

This boiler is manufactured by the Carr Boiler Co., Monadnock Block, Chicago, Ill.

National Direct Contact Heater and Purifier

The back head of this heater consists of an oil separator of the same diameter as the shell. A manifold, cast on the front head, serves as a distributing chamber to the double cast-iron contact pipe, shown in Fig. 1, which is closed at the outlet ends. The inner water pipe is connected to the water manifold on the front head, through which the water is discharged. The outer or steam pipe is connected to the outlet of the steam separator on the back head.

The water pipe has a port opening its entire length on the upper side, to the outside of the steam pipe, which has a port extending its full length at the bottom. Water entering the water pipe flows upward through the port, and passes in a thin film over the outside surface of the steam pipe until it reaches a rib projecting from each side of the port opening at the bottom, where it is broken up into fine spray.

The only outlet for the steam in the steam pipe is through the port in the bottom. The cold-water pipe on the inside of the steam pipe is surrounded by steam, and the coldest water is heated by the hottest steam through contact with the thin wall of the water pipe. The water is further heated as it passes over the outer surface of the steam pipe, and finally all of the water and all of the steam are brought into direct contact as the steam flows through the bottom port.

The hot water and condensed exhaust are carried by pans direct to the sediment chamber at the bottom of the heater, where the solid and heavy impurities settle. The water then passes upward through a filter bed which removes the remaining impurities. Connection between the feed-water pump and the hot-water chamber is made above the filter bed. The filter is so designed that in case it should become clogged, heated water can be bypassed and fed direct to the pump.

Fig. 2 shows the oil separator. The large area allows the incoming steam to expand and reduce its velocity to a point where oil or water will fall out of the current by gravity. These particles impinge on the main baffle-plate, which is provided with vertical ribs to prevent side travel of water or oil. A series of tube ports are fitted in the baffle-plate. The steam makes a right-angle change in direction upon striking the baffle-plate and the projecting tubes cause a further change in its direction of flow. These reversals of travel prevent oil from being carried beyond the main baffle-plate.

This heater is manufactured by The National Pipe Bending Co., New Haven, Conn.

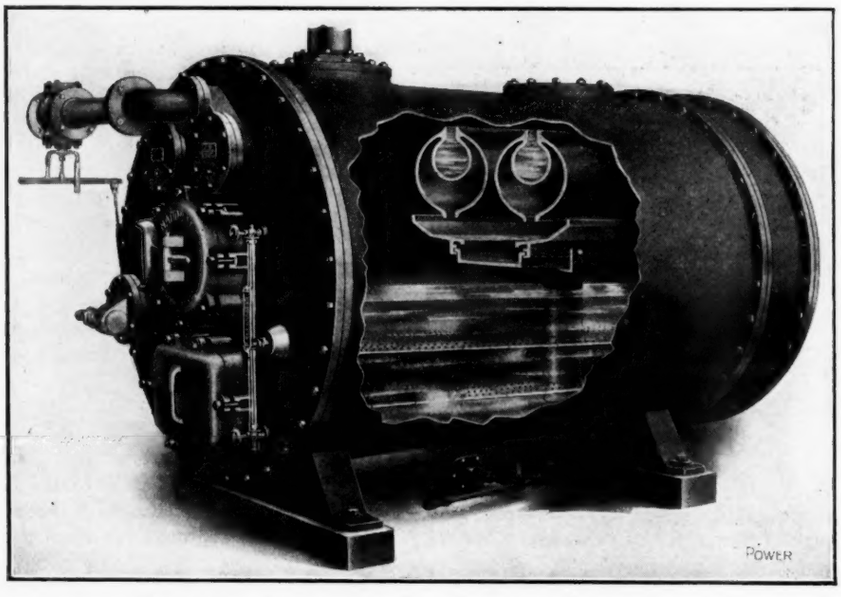


FIG. 1. SHOWING THE HEATING TUBES OF THE HEATER

FIG. 2. OIL SEPARATOR

The story is told that a letter received some years ago by the Westinghouse Machine Co. said that the writer had been using one of its standard vertical engines with eminent satisfaction. For eight years it had been in continuous service night and day, handling its load without a hint of trouble, but that "upon shutting it down the other evening it went all to pieces." The letter was passed to the eminent inventor whose name the company bears, and handed back with the remark: "Ask the blamed fool what he shut it down for."

Study Questions

The answers to these questions will appear in the issue of May 21:

1. An engine having 5 per cent. clearance, cutting-off at quarter stroke, with 85 lb. initial pressure (gage) and exhausting at 15 lb. absolute, has an m.e.p. of 44.6 lb. What would be the "diagram factor"; i.e., what percentage of the ideal diagram would be covered by the actual diagram, the product of the volume and pressure being assumed to remain constant during expansion?

2. If one man can do a piece of work in eight days, another in 12 days and another in 10 days, how many days will it take all three to do the work if all trhee work together?

3. An engine taking steam at 120 lb. absolute, containing 2 per cent. of moisture, requires 16 lb. per horsepower-hour running condensing. If the cooling water in the condenser has an initial temperature of 60 deg. F. and a final temperature of 100 deg. F., how many pounds of water will be required to condense 1 lb. of steam exhausted by the engine, neglecting radiation?

4. What pressure would be necessary to deliver 200 gal. of water per minute through a horizontal 4-in. pipe line 400 ft. long, the water discharging into an open tank?

5. The volume of a spherical segment is 29.3216 cu.ft., the diameter of the sphere is 6 ft.; required, the height of the segment and the length of its base.

Truro (N. S.) Plant Wrecked

On May 2,, the power plant of the Chambers Electric Light & Power Co., at Truro, N. S., was badly wrecked by the explosion of a flywheel, While there were no lives lost, it is said that the monetary loss was large.

According to the press reports, the flywheel burst at 7:15 a.m., the flying pieces destroying the dynamo and wrecking the power-house interior. One piece, weighing 172 lb., was blown through the roof, landing in front of St. Andrew's church, 270 yd. distant. Another, weighing as much, was blown through the big brick wall and forced its way through the second brick wall of an adjoining furniture store, and a big fragment tore through the power-house wall and then through the wall of the laundry adjoining.

The president of the company was just about to enter the door of the power house and the concussion hurled him many yards away, unhurt. An employee dashed into the building amid falling bricks and plaster and débris and shut off the steam.

As the company has duplicate emergency engines and dynamos, the light and power service was not interrupted.

Boiler Explodes in Saw Mill

On Friday, Apr. 19, a boiler exploded at Combs, Tenn., killing the fireman and injuring two other employees.

According to our correspondent, the boiler was 36 in. by 12 ft. and connected to a larger boiler with no stop valve in between, and only one safety valve for both. The lever of the safety valve was not notched and a large screw jack was used as a weight which would slip to the end of the lever while the boiler was in operation, the weight being moved back every morning before starting the fires.

The boiler had several patches on it and had not been in service for about three years until a week previous to the explosion; its plates were ¼ in. thick, but many of them were so badly corroded that they were reduced to ⅛ in. Although 90 lb. was the usual pressure, 140 lb. was carried at the time of the explosion. The boiler was not insured and therefore never inspected by an official inspector.

Examination of the plates showed that while no rivets were sheared the plates were torn in many pieces. The larger boiler was thrown about 30 ft. from its settings, and the sheets were considerably sprung and distorted. Our correspondent said he was advised that "She was all right, however, and another second-hand boiler would be installed in place of the exploded one."

The A B C of Boiler Room Chemistry

Under the auspices of the Institute of Operating Engineers, an interesting and instructive lecture on the essentials of boiler-room chemistry was delivered by H. J. Atticks, a member of the institute, in the Engineering Societies Building, at 29 West Thirty-ninth St., on the evening of Apr. 25.

The speaker stated that the purpose of the talk was not to go into the complexities of chemistry, but rather to give a comprehensive idea of the fundamentals of the science and its relation to power-plant practice.

He told of the indestructibility of matter and defined the meaning of an element; "compounding of the elements and the study of compounds" was the chief purpose of chemistry. The symbols of the chemicals met with in power-plant practice were also clearly explained, as well as the meaning of qualitative and quantitative analyses, atomic weight and chemical affinity.

Mr. Atticks then took up the analysis of boiler waters, illustrating his talk by actual tests of water containing carbonate of lime and sulphate of lime. These samples were heated in test tubes to ascertain the amount of precipitation, and tubes were then passed through the audience for inspection. The action of dangerous corrosive agents in water, such as chloride of magnesium and sulphuric acid, were well explained.

Heat and the combustion of coal were next taken up and were followed by an actual analysis of the flue gases with the Orsat apparatus. This part of the lecture was particularly instructive as the functions, construction and manipulation of the apparatus were given in detail. It was explained that the pipettes of the apparatus contained potassium hydrate for determining the percentage of carbon dioxide, solution of potassium pyrogallate for determining the percentage of oxygen and cuprous chloride for determining the percentage of carbon monoxide respectively, and that the analyses should be taken in the order given. The readings of the apparatus were made plainly visible by placing a strong light back of the Orsat.

The lecture was a success both in attendance and in the practical manner in which the speaker handled his subject.

Diesel Engines for America

The *London Times* states that on the recommendation of a commission of American engineers sent especially to Europe to visit the leading firms of Diesel-engine makers in England and on the Continent, an English firm has made arrangements whereby the General Electric Co. will build Diesel engines to their design.

The A. S. M. E. Convention

The date for the spring meeting of the American Society of Mechanical Engineers has been changed to the last week of May, opening on Tuesday, May 28, and closing on Friday, May 31. Every effort is being put forth by the committee on meetings and the members in Cleveland to make this one of the great conventions of the society, and the variety and importance of the city's industrial works and its attractiveness as a whole will make it one of the most interesting cities in the country for a meeting of engineers.

A tentative program of the papers and entertainment, subject, however, to change, follows. The professional sessions will be held in the Hall of the Chamber of Commerce.

TENTATIVE PROGRAM

TUESDAY, MAY 28

Opening of registration at headquarters, Chamber of Commerce Hall, after 10 a.m.

Informal reception, 4 to 6 p.m., at the home of Mr. and Mrs. Ambrose Swasey, 7808 Euclid Ave.

Membership reunion and informal reception, at 8:30 p.m., at the Chamber of Commerce Hall.

WEDNESDAY, MAY 29

Business meeting, 10 a.m.; reports of tellers of election and committees, and new business.

Professional session, 10:30 a.m. Papers: "A New Analysis of the Cylinder Performance of Reciprocating Engines," J. Paul Clayton; "Equipment of a Modern Flour Mill on a Gradual Reduction System," John F. Harrison and W. W. Nichols; "Design and Mechanical Features of the California Gold Dredge," Robert E. Cranston. To be read by title only; discussion is invited.

Gas-power section, 10:30 a.m.; simultaneous session in Chamber of Commerce library. Paper: "Problems in Natural Gas Engineering," Thomas R. Weymouth. Other papers to be announced.

Special inspection trip for ladies, at 10 a.m., to the plant of the H. Black Co., cloak manufacturers.

Members and guests will be entertained at luncheon at 12:30 p.m. in the Chamber of Commerce Hall.

Excursions at 2 to 4 p.m.: Inspection by members of local manufacturing and power plants; automobile trip for ladies through the parks; tea will be served at the Country Club at 4 p.m., to which members and guests are invited.

Lecture, 8:30 p.m.: "Sound Waves: How to Photograph Them and What They Mean," Dr. Dayton C. Miller, of the Case School of Applied Science. The lecture will be illustrated with apparatus and experiments and especially with the new instrument, the "Phonodeik," for projecting sound waves directly upon the screen.

THURSDAY, MAY 30

Professional session, 10 a.m. Papers: "New Processes for Chilling Cast Iron," Thomas D. West; "Strength of Steel Tubes, Pipes and Cylinders under Internal Fluid Pressure," Reid T. Stewart; "On the Control of Surges in Water Conduits," W. F. Durand; "Speed Regulation in Hydro-electric Plants," William F. Uhl. To be read by title only; discussion is invited.

Thursday afternoon, at 1 to 5 p.m., there will be an excursion on Lake Erie, and in the evening, at 8:30 p.m., a reception and dance at the Colonial Club.

FRIDAY, MAY 31

Professional session, 10 a.m. Papers: "The Present State of Development of Large Steam Turbines," A. G. Christie; "A Discussion of Certain Thermal Properties of Steam," G. A. Goodenough; "The Reduction in Temperature of Condensing Water Reservoirs Due to Cooling Effect of Air and Evaporation," W. B. Ruggles; "Results of Tests on the Discharge Capacity of Safety Valves," E. F. Miller and A. B. Carhart. To be read by title only; discussion is invited.

The members and guests will be entertained at luncheon at the Chamber of Commerce Hall promptly at 12 o'clock.

An inspection of the plants of the Goodrich Rubber Co., the Wellman-Seaver-Morgan Co., at Akron, and the Diamond Match Co., at Barberton, will be made at 12:30 p.m.; the ladies are invited to make the trip to Akron.

The plans for the entertainment and reception of members and their guests are in charge of the local members in Cleveland. The executive committee, composed of the chairmen of the various sub-committees, is as follows: Ambrose Swasey, chairman; R. H. Fernald, vice-chairman; R. B. Sheridan; treasurer, F. W. Ballard, secretary; S. T. Wellman, E. P. Roberts, Worcester R. Warner, G. E. Merryweather, A. G. McKee.

N. A. S. E. State Conventions

The following gives the places and dates of the annual state conventions soon to be held by the associations of the National Association of Stationary Engineers:

California, Santa Barbara.....May 23-26
Colorado, Idaho Springs.....June 7-8
Connecticut, Bridgeport.....June 28-29
Illinois, Decatur.....May 23-25
Indiana, Evansville.....June 6-8
Iowa, Sioux City.....June 27-29
Kentucky, Owensboro .....
Massachusetts, Northampton..July 11-13
Michigan, Flint.....Aug. 1-3
Minnesota, Winona.....July 17-20
Missouri, Joplin.....June 20-22
New Jersey, Newark,
May 30, 31, June 1, 2
New York, Yonkers.....June 14-16
Ohio, Lima.....June 20-22
Pennsylvania, DuBois.....June 7-8
West Virginia, Clarksburg .....
Wisconsin, Racine.....July 24-27

Pittsburg Meeting of the Ohio Society

The Ohio Society of Mechanical, Electrical and Steam Engineers is determined to set a new high record for its coming meeting at Pittsburg on May 16, 17 and 18.

A special effort is being made by the Pittsburg committee to make the entertainment program of sufficient interest to induce a large attendance of the members' ladies. During the trip to the testing station, Bureau of Mines, and the laboratories of the Geological Survey, the ladies will be entertained at the Arsenal playgrounds, near-by.

The opening session, on Thursday evening, will be at the rooms of the Engineers' Society of Western Pennsylvania, Oliver Building. An "owl" party for the men will be organized immediately after the opening session at Engineers' Hall. It will visit the Phipps power plant at 11 p.m. and inspect the powdered coal stoking equipment, the largest installation of this type in the world. The inspection will last until 12 o'clock, when the party will adjourn to the Pittsburg Natatorium for a midnight swimming party.

On Friday an automobile tour of the residence district has been arranged for the ladies, starting at 10 a.m. from Hotel Schenley. The trip will conclude at 12:30 at the Margaret Morrison Carnegie School for Women, where luncheon will be served, followed by an inspection trip through the schools.

At the close of the Friday morning session the men will lunch with the students of Carnegie Technical Schools, and tour the engineering and mechanical department and testing laboratories, concluding in time to join the ladies and attend the ball game at Forbes Field at 3:30 p.m., as guests of the Pittsburg committee.

At 6 p.m. Friday, a complimentary dinner will be tendered the members and their ladies at the Hotel Schenley.

The committee has arranged for preferential trips to the Westinghouse works, the Jones & Laughlin Steel Co., and other Pittsburg plants for Friday afternoon or Saturday morning, for those members who are willing to skip a part of the regular program.

Convention of the A. O. S. E.

The twenty-sixth annual convention of the American Order of Steam Engineers will be held at Allentown, Penn., during the week beginning June 3. The mechanical exhibit will be located at the Fair Grounds, and in a spacious hall, adjoining the display, the business sessions of the delegates will be held.

Arrangements have been made for the accommodation of over 100 exhibitors, and many of the booths have already been taken.

An excellent program of entertainment has been prepared, and the general outlook seems to warrant a most successful convention.

Master Boilermakers' Convention

The sixth annual convention of the Master Boilermakers' Association will be held in Pittsburg from May 14 to 17. The headquarters will be in the large English room of the Fort Pitt Hotel. The local committee are J. B. Smith, chairman; Daniel S. Rise and Charles J. Reynolds.

Mayor William A. Magee will make the address of welcome, and other addresses will be given by D. F. Crawford, of the Pennsylvania R.R.; L. H. Turner, of the Pittsburgh & Lake Erie R.R.; William McConway, of the McConway & Torley Co., Pittsburg; M. O'Connor,

William H. Laughbridge, T. W. Lowe, George Wagstaff and George W. Bennett, the president of the association.

The women's auxiliary will also hold its annual convention in the Fort Pitt Hotel at the same time. It is said that smoke prevention will be one of the most important topics under discussion.

N. E. L. A. Seattle Convention

Among the papers and reports to be read at the Seattle convention of the National Electric Light Association on June 11 to 13, are "The Desirability as a Central-station Load of Pumping for Municipally Owned Water Works," Charles A. Munroe; "Educating Central-station Employees," H. E. Grant; "Twenty-four-Hour Service in Small Central Stations," Taliaferro Milton; "Work and Publications of the U. S. Government Relating to Hydro-electric Development," J. S. Hoyt; reports on power transmission; "A Plan for Increasing Power Load," H. W. Cope; reports of committees on prime movers and electrical apparatus; "Care and Operation of Transformers," W. M. McConahey.

Several of these papers will be abstracted in early issues of POWER.

Eighth International Congress of Applied Chemistry

The Eighth International Congress of Applied Chemistry will be held in Washington and New York, on Sept. 4 to Sept. 13, under the patronage of President Taft. The honorable president of the congress is Prof. Edward W. Morley, Sc.D., Ph.D., LL.D.; the president, W. H. Nichols, Sc.D., LL.D., and the secretary, Dr. Bernhard C. Hesse, 25 Broad St., New York City.

A preliminary pamphlet may be obtained from the honorable secretary of the British organizing committee, Charles G. Cresswell, Society of Chemical Industry, Palace Chambers, Westminster, London, S.W.

Special Meeting of N. A. S. E., Detroit

The Detroit branch, N. A. S. E., gave a reception to National President E. J. Kearny, of Boston, on May 6, and he was shown many courtesies during the day. At 8:30 p.m., in Association Hall, Ray Silver, president of Council No. 7, introduced Mr. Kearny, who in his address urged the members to keep in touch with progressive methods of operating engineering and told of the necessity for a state license law. He advocated the appointment of a civil-service board of examiners which would pass upon the fitness of engineers and boiler inspectors, and spoke of the advantages of state lectures on engineering.

Among the other speakers were State President Fuller, of Kalamazoo; Past National and State Presidents E. J. Jacques and Pearce; Vice-president Cressey, of Council No. 1, and Charles Ellis, president of the United Engineers.

Sixth Congress of International Association for Testing Materials

The organizing committee under whose auspices the sixth International Congress for Testing Materials will be held on Sept. 2 to 7 at the Engineering Societies Building, New York City, announces an informal reception on Monday evening, Sept. 2, under the joint auspices of the American Society for Testing Materials, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the American Institute of Mining Engineers.

The congress will convene at 10 o'clock a.m., Sept. 3, with an address of welcome by Dr. Henry M. Howe, acting president, and by national, state and city officials. Over 150 reports and papers are in hand or promised, including 35 American papers.

A list of the delegates already appointed, together with the titles of the foreign papers to be read, are included in bulletin No. 2 issued in April by the organizing committee, in which is also given the itinerary of the excursions to points of interest in neighboring cities. The bulletin may be had on application to H. F. J. Porter, secretary of the committee, 1 Madison Ave., New York City.

SOCIETY NOTE

The twelfth annual six-weeks summer school of the College of Engineering, University of Wisconsin, will open on June 24. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shopwork and surveying, in addition to which subjects may be taken in the College of Letters and Science. Address F. E. Turneaure, University of Wisconsin, Madison, Wis., for further particulars.

BOOKS RECEIVED

STEAM TURBINE DESIGN. By John Morrow. Longmans, Green & Co., New York. Cloth; 471 pages, 5¾x9 in.; 150 illustrations; plates; tables. Price, $4.50.

THE STEAM TURBINE. By Robert M. Neilson. Longmans, Green & Co., New York. Fourth edition; cloth; 651 pages, 5¾x9 in.; 415 illustrations; plates. Price, $5.

CENTRIFUGAL PUMPING MACHINERY. By Carl G. de Laval. McGraw-Hill Book Co., New York. Cloth; 184 pages, 6x9 in.; 160 illustrations; tables. Price, $3.

HOUSE WIRING. By Thomas W. Poppe. The Norman W. Henley Publishing Co., New York. Flexible cloth; 125 pages, 4½x6½ in.; 74 illustrations. Price, 50c.

KNOTS, SPLICES AND ROPE-WORK. By Hyatt Verrill. The Norman W. Henley Publishing Co., New York. Cloth; 128 pages, 4½x6½ in.; 148 illustrations. Price, 60c.

ELEMENTARY INTERNAL COMBUSTION ENGINES. By J. W. Kershaw. Longmans, Green & Co., New York. Cloth; 174 pages, 5x7½ in.; 117 illustrations. Price, 90c.

OBITUARY

SPENCER NEEMES

Spencer Neemes, of the Neemes Brothers, Troy, N. Y., died suddenly at his home, 150 Pawling Ave., Troy, N. Y., on May 5.

Mr. Neemes was born in Whitehaven, England, May 6, 1856, and came to this country with his parents a year later. The family located in Albany, where Mr. Neemes was educated in the public schools. He moved to Troy 38 years ago and with his father and his brother Joseph established the foundry business now carried on under the name of Neemes Bros. He was noted for his mechanical skill and inventive capacity, a genial companion and a public-spirited citizen, a well known Mason, a member of the Troy Chamber of Commerce and devoted much of his time and money to unostentatious charity.

Spencer Neemes is survived by his wife, formerly Cornelia M. Cornelius, a daughter, Grace, a son, Oscar G., his grandson, Spencer G. Neemes, and his brother Joseph. The interment was at Oakwood on May 7 with the Knights Templar service.

PERSONAL

Mark A. Replogle has been appointed district agent for the Northern Mississippi River and Lake State sections by the Lombard Governor Co., with offices in the Fisher Building, Chicago. Mr. Replogle is well known in waterwheel governor circles and formerly had charge of sales in the New England and St. Lawrence River sections.

Lawrence Paddock, formerly of the engineering department of the Prudential Insurance Co., of Newark, N. J., has taken charge of the plant of the Rosenbaum Jewelry Co., of that city. Mr. Paddock will be remembered as the engineer whose coolheadedness resulted in saving a number of employees at the Nathaniel Glass Co.'s fire in High St., Newark, on Nov. 26, 1910.

Earnest T. Child, George M. Scott and John E. Jeffery, with the name Child & Scott Co., have succeeded the corporation of G. A. Suter & Co., 108 to 114 Wooster St., New York City, engineers and contractors for heating and ventilating apparatus. The members of the new firm have been associated with Mr. Suter for many years and will continue in the same line of engineering.

Moments with the Ad. Editor

Many of you who read this page will be surprised to know that thousands and thousands of dollars have been spent in the past few years by manufacturers of machinery and allied lines in what are termed "general magazines."

That is to say, they have advertised to everybody in the hope of hitting somebody.

This would be fine business if they had only to *pay* for what they *hit*.

General magazines must of necessity aim to interest the universe from the world of politics to the world of fashion.

Hence their circulations are tremendous, and their readers as varied in pursuits, aims and occupations as the crowd that watches a circus parade.

Their advertising rates are based, as are those of all papers, upon the *quantity* of circulation. The advertiser pays for *everything*—and gets an infinitesimal portion of the lot as prospective customers.

The price per page, one time, for general magazines runs from $100 to $4000.

Now, here are some census figures that will show you, who are interested from the *reader's* point of view, how little chance a *general* advertiser, making, say, clothing, has in a *general* magazine.

Then you can figure how little chance a *machinery* advertiser has in general papers.

All men wear clothes—only a slight proportion of them buy machinery.

Assume that this clothing maker's product sells for an average of $30 per suit.

Fifty-two per cent. of the people live in the country; 10⅔ per cent. in semi-urban and 37⅓ per cent. live in cities and towns.

An average family consists of five persons.

Nearly 33 *per cent.* of these families have an average income of less than $400 per year or about $80 per capita.

Not many $30 suits to be sold there.

About 21 per cent. of these families have an annual income of $400 to $600.

Some 15 per cent. have an annual income of $600 to $900.

Only 10½ per cent. of them have an annual income of $900 to $1200.

Only 7½% of them have an annual income of $1800 to $3000. An average per member of the family of $360 to $600. (Now you're in the thirty-dollar-suit class.)

And only 5 per cent. have over $3000. (They are out of the "ready-made" class into made-to-order clothing.)

Some problem to advertise profitably, isn't it?

If your article is for men only or women only, your public is halved.

There are 9,000,000 negroes—10 per cent. of the population is black.

If your general magazine is a low priced one catering to the popular idea of easy fiction, a-b-c politics, and how-to-live-on-30-cents-a-day, the circulation strikes an average of the country's population.

How many machinery buyers are there among them all?

Now witness why POWER and other good technical papers can *profitably* advertise machinery and allied things.

The editorial contents of this paper automatically limit the readers of it to men actually interested in the generation and transmission of power.

Those men represent concerns which have the money to buy that machinery which will enable them to make more money!

The circulation instead of being hundreds of thousands is 29,000.

That means a rate in proportion.

The advertiser of power belting, for instance, who spends $4,000 for a single page once in a general medium can buy more than a page in *every* issue of POWER for 52 weeks.

Instead of making the here-today, gone-to-morrow impression, he gets the powerful, cumulative effect of week after week advertising.

Verily, the machinery man who listeth to the lure of the general magazine is putting his shekels where they do him the least good.

It's great to be able to show the family your ad. in "Munbody's;" it's a heap of satisfaction to show the barber, the butcher and the landlord—but, bless you, it doesn't bring home the bacon.

* * * *

Mr. Power Reader, get this point:

The general magazine will take any decent ad.—barring medical, cigarette and liquor stuff—whether for baby's-food or hack-saws. This paper, POWER, won't take anything that isn't by way of being intended for use in a power plant.

That is another reason why you can read the Selling Section through with no danger of wasting your time—with full assurance of finding help in your *business*.

NEW EQUIPMENT

ATLANTIC COAST STATES

The Central Massachusetts Electric Co. contemplates extensive improvements to its plant at Palmer, Mass. H. C. Page, Springfield, Mass., is general manager.

A bill appropriating $195,000 for the equipment of the new power plant in the Capitol Bldg., Albany, N. Y., has been passed.

Plans are being prepared by M. Voorman, Gloversville, N. Y., for the construction of a water-works system, at Hobart, N. Y.

The Keystone Leather Co., Camden, N. J., will construct a new engine room in connection with its establishment. The installation of a 500-hp. oil engine, pumps and compressors will be required. Estimated cost, $40,000.

The Richton Lumber Co., Richton, Miss., contemplates the construction of an electric-light plant at Richton in connection with its mills.

Plans are being prepared by F. H. Bent, state architect, for the construction of a new boiler plant for the New Jersey State Home for Girls, at Trenton, N. J.

The installation of an electric-light plant at Freehold, N. J., is under consideration. Estimated cost, $50,000.

Plans are being prepared for the construction of a municipal electric-light plant at Newton, N. J.

The city council of Orange, N. J., is considering the improvement and enlargement of the municipal lighting plant to supply electricity for commercial purposes. Henry M. Berg is city engineer.

The construction of an electric-light plant at Pine Grove, Penn., is contemplated by S. Troppell, of Bloomsburg, Penn.

The Glen Willow Ice Co., Philadelphia, Penn., contemplates the installation of a new ice plant. P. P. Lubert is president.

Plans, prepared by Horace Trumbauer, Land Title Bldg., Philadelphia, Penn., for the construction of a new hotel, at 1229 Chestnut St., Philadelphia, include the installation of a power plant.

A power plant will be installed in the new bank and office building of the Miners' Saving Bank, to be erected at Wilkes-Barre, Penn. Plans have been prepared by D. H. Burnham Co., 42 Cedar St., New York, N. Y.

The state board of health has ordered the borough of Ashland, Penn., to install a filtration plant.

Brunswick, Md., contemplates the construction of a municipal electric-light plant. A. G. Horino is mayor.

SOUTHERN STATES

The Clinchfield Coal Corporation contemplates the construction of three substations in connection with its mines at Dante, Va.

Fort Meade, Fla., has voted a bond issue for $19,000 for the construction of a water-works system. R. C. McClellan is mayor.

Biloxi, Miss., has voted a bond issue of $70,000 for the construction of a water-works system.

Gale P. Kyle contemplates the construction of a water-works system at Rogersville, Tenn.

The Kentucky Traction & Terminal Co. will build a substation at Nicholasville, Ky. I. L. Oppenheimer, Lexington, is general manager.

CENTRAL STATES

The Licking Light & Power Co. proposes to construct a new power plant at Newark, Ohio, in the near future. H. L. Montgomery is manager.

F. Hilgemier & Co., Indianapolis, Ind., will receive bids soon for furnishing two 50-hp. boilers with automatic stokers and for the construction of a smokestack, in the plant on Raymond St.

A franchise has been granted to Harry D. Baker, Croix Falls, Wis., to construct and operate an electric-light plant at Balsam Lake, Wis.

WEST OF THE MISSISSIPPI

A franchise has been granted to E. N. Miller to construct and operate an electric-light plant at Columbus Junction, Iowa.

The citizens of Humeston, Iowa, will soon vote on the proposition to issue bonds of $15,000 for the construction of an electric-light plant.

J. O. Ruggles, Martinsburg, Iowa, contemplates the construction of an electric-light plant at Hedrick, Iowa.

A. S. Ageton, Tama, Iowa, contemplates the construction of an electric-light plant at Gladbrook, Iowa.

The Seager Electric Light & Engine Co., Lansing, Mich., contemplates the construction of an electric-light plant at Merrill, Iowa.

The electric light and water department, Warren, Minn., contemplates the installation of an additional 150-kw. generating unit in the power plant. W. R. Haney is superintendent.

The citizens of Marine, Minn., are considering the proposition to issue bonds for the construction of an electric-light plant.

The village council of Big Falls, Minn., has granted a franchise to Dahl & Shipley to construct and operate an electric-light plant at Big Falls.

The Lethert Electric Co., St. Paul, Minn., contemplates the installation of an electric-light system in Cold Spring, Minn.

The Glencoe Electric Light Co., Glencoe, Minn., contemplates the construction of an electric-light plant at Howard Lake, Minn. H. B. Rutledge is manager.

The Minneapolis, St. Paul, Rochester & Dubuque Electric Traction Co. plans to construct an electric-light plant at Antlers Park, Northfield, Minn. D. S. Smith, Minneapolis, is general manager.

The Williston Electric Construction Co., Williston, N. D., has been granted a franchise to construct and operate an electric-light plant at Ray, N. D.

Augusta, Kan., is considering the installation of an electric-light plant. J. R. Switzer is city engineer.

The citizens of Axtell, Kan., are considering a bond issue for the installation of an electric-light plant.

H. W. Chapman has been granted a franchise to construct and operate an electric-light plant at Miltonville, Kan.

The council of Turon, Kan., is considering the construction of an electric-light plant.

G. W. Brown is considering the construction of an electric-light plant at Imperial, Neb.

The proposition to equip the municipal electric-light plant to supply electricity for commercial lighting is being considered by the citizens of Lincoln, Neb.

The Commercial Club, of Kennard, Neb., is interested in the project to construct an electric-light plant.

The installation of a water-works system at Collegeview, Neb., is under consideration. Estimated cost, $25,000. D. G. Weiss is village clerk.

Gretna, Neb., will soon receive bids for the construction of a water-works system. Plans are being prepared by Bruce & Standevin, Bee Bldg., Omaha, Neb.

Bonds for $60,000 have been voted for the improvement of the water-works system, at Yankton, S. D.

Bids will be received by J. E. Nolan, city engineer, Shelby, Mont., until 7 p.m., June 10, for the construction of a water-works system.

The citizens of Henrietta, Tex., have voted to issue bonds of $18,000 for the construction of a water-works system.

Plans and estimates are being prepared by the city electrician, of Dallas, Tex., for the construction of an electric-light plant.

Bids will be received by C. A. John, mayor of New Braunfels, Tex., until May 22, for the construction of a municipal electric-light plant and water-works system.

Bids will soon be received by the city of Ponca, Okla., for the construction of an electric-light plant.

Purcell, Okla., has voted a bond issue of $100,000 for the construction of an electric-light and water-works plant.

Bids will be received by G. H. Scott, Quartermaster, Fort Bayard, N. M., until May 15, for furnishing two boilers, two generators and engines.

The Telluride Power Co. contemplates extensive improvements to its power plant at Grace, Idaho. L. L. Nunn, Provo, Utah, is manager.

Burley, Idaho, contemplates the construction of a water-works system.

The citizens of Murray, Utah, are considering a bond issue of $50,000 for the construction of a municipal power plant.

The Northwestern Electric Co. contemplates the construction of a new central station at Portland, Ore. D. C. Green, Albany, Ore., is manager.

Clatshanie, Ore., has voted bonds for $30,000 for the construction of a water-works system.

The citizens of Grant's Pass, Ore., will soon vote on the proposition to issue bonds of $4000 for the construction of an electric-light and water-wrks plant.

The citizens of Oxnard, Calif., have voted bonds for $39,000 for the construction of an electric-light plant. Olmstead & Gillelen, Los Angeles, are consulting engineers.

Samuel Henry is interested in the installation of an electric-light plant in the Physicians' Bldg., Stockton, Calif., at a cost of $20,000.

The Empire Mining Co., Grass Valley, Calif., will construct a power plant to supply electricity to its mines.

The Merced Stone Co. is making arrangements for the construction of a new substation at Jasper Point, Calif.

Marysville, Calif., contemplates the installation of an electric-light plant.

Everybody Wants American Quality Products

50% **increase** in sales is our record to date over the same period last year.

Our Gauge Department has been increased to a capacity of 1000 perfect American Quality Gauges per day.

Our Valve Department, Indicator Department, in fact **every** Department in our Factory is being pushed to capacity.

We have been obliged to add new Moulding Machines in our Brass Foundry.

We Are Shipping Our Products From Eastport to Japan

The most important indication of this increase is in the great volume of small orders pouring in from everywhere It is the natural result of fighting along one line only: **Quality;** regardless of the challenge of manufacturers of low grade products to meet their prices—and with a deaf ear to the cry of "hard times."

There is enough natural demand to keep any high standard producer busy. We are proving it.

Quality—American Quality—pays.

The name American on any appliance for the control or measuring of pressure—Steam, Gas, Ammonia or Hydraulic—is a guarantee that that appliance is the very best produceable.

We will gladly send you our General or Pocket Catalog on request.

American Steam Gauge & Valve Mfg. Co.

208 Camden Street, Boston, Mass.

ATLANTA	CHICAGO	NEW YORK	PITTSBURGH	MONTREAL
525 Candler Bldg.	130 N. Jefferson St.	114 Liberty St.	Jenkins Arcade Bldg.	444 St. James St.

Every Engineer Wants The American-Thompson Indicator

The ownership of an American-Thompson Indicator is a sign of the highest competence and merit.

Case after case could be cited of instances where engineers have secured raises, landed better jobs or made extra "time off" money through the ownership of an American-Thompson Indicator.

The great value to you in the American-Thompson lies in its ability to show you conditions as they actually are and to enable you to make them what they actually should be.

It is this that marks the competent engineer. It enables him to effect savings in operation costs and to increase the efficiency of his entire plant. Competent engineers win for their concerns and for themselves.

The American-Thompson Impoved Indicator is the recognized standard Indicator of the world, because—

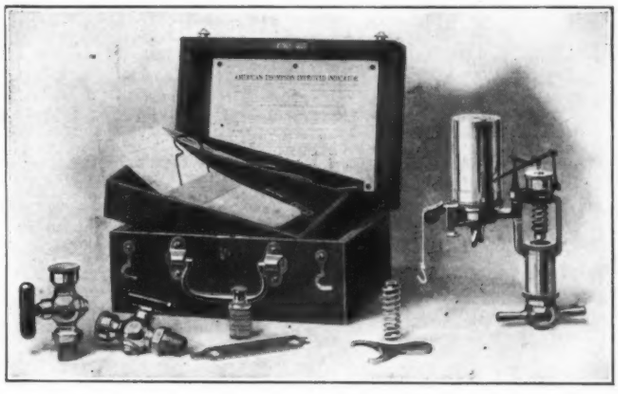
Month in and month out it produces diagrams of unvarying accuracy. It tells the truth always because it is made that way. It's got the right principle to begin with. It is made by a concern with 40 years "know how" back of it.

It is made by skilled mechanics who've made nothing else for years. It's made of a special metal that lasts and lasts. It is made complete in one factory, and then—It is tested under actual conditions and no instrument leaves the factory unless it meets the requirements of a test more severe than that actual practice requires.

$5.00 Down $5.00 Monthly

The price of the outfit as shown is $55.00, with reducing wheel $65.00. The cost of the detent motion is $15.00. The terms are easy—made easy to put this standard instrument within your immediate reach—$5.00 down and $5.00 per month.

Send $5.00 and two good references today; we will ship outfit at once and it's yours for examination for 5 days. Don't put this matter off any longer—take this opportunity now—you'll be the gainer.



The American-Thompson is the original Thompson Indicator. It is the most imitated instrument on the market. To be absolutely sure of getting the right indicator, ask for the "American-Thompson Indicator made by The American Steam Gauge and Valve Mfg. Co." Always specify it in that way.

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Sales Offices in New York, Chicago, San Francisco, Pittsburg, Atlanta, Montreal

THE BEST HOUSES EVERYWHERE SELL OUR PRODUCTS

SIGN AND MAIL COUPON

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Send me full details of offer No. 161

Name . . . . . .

Address . . . . . .

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

FOR ELECTRIC lighting and refrigeration plant in the city of Panama, Republic of Panama; five boilers and four engines; total hp., 1250; 100-ton ice plant; on duty eight hours per day; salary $250 per month; state age and experience, especially the types of engines you have run. Box 658, Power.

FOR NIGHT RUN, 7 p.m. to 7 a.m., water and steam power central station plant; total capacity, 675 kw., in four units; three steam belt connected, one waterwheel direct connected; location, northern part of Connecticut; salary, $70 per month; must be steady, sober and reliable; reply, stating age, married or single, experience and references. Address Box 657, Power.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

SELLING AGENTS wanted in important centers for Betson plastic fire brick; see page 66 in this issue.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

ENGINEERS can make big pay selling O'Keefe's patented cooling device for engines; no competition to meet. Address W. J. O'Keefe, 671 N. State St., Chicago.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

AGENTS WANTED to sell forced draft blowers and damper regulators; will give exclusive territory to right parties; commission on sales. Turbo-Blower Co., 30 Church St., New York.

AGENTS selling to steam plants can make big money selling for us; no samples; no experience is necessary. Armstrong Mfg. Co., Springfield, Ohio.

SALESMEN who have established trade among boiler users; good salary, expenses and liberal bonus. Reiter Boiler Cleaner Co., Elgin, Ill.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators, traps and exhaust pipe heads; not necessary to represent entire line if interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

I WISH to correspond with a firm desiring the service of an uptodate master mechanic. Box 655, Power.

MECHANICAL and electrical engineer, technical graduate, 32, desires operating position; experience in designing and erecting machinery for engine building company, and as testing engineer for group of power plants. Box 652, Power.

ENGINEER, married, 25 years' experience; sober, reliable and efficient; in present position six years; will accept position as chief engineer or first assistant of electric power plant, waterworks or factory plant. Address Box 659, Power.

CHIEF ENGINEER, 20 years' experience of successful operating and installing steam and electric power plants; familiar with central railway and lighting station, high tension and direct current equipment; first class Massachusetts license; 40 years of age and best of reference. Box 650, Power.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

WANTED—Transactions of the American Institute of Electrical Engineers. Vols. 1 to 25, 1884-1909. Box 654, Power.

WANTED—To buy electric light plant in a good city of about fifteen hundred to three thousand people, west of the Mississippi. Address W. M. Donner, Rossfork, Idaho.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

20x48 CORLISS engine, excellent condition, $650. Duzets & Son, Hudson Terminal, New York.

CHEAP—One 30-hp. Diesel oil engine with duplicate parts of a wrecked one. Seib Bros., 96-100 Boyd Ave., Jersey City, N. J.

350 KW. WESTINGHOUSE generator, 250 volts, direct connected to 24x36 heavy duty Corliss engine; unit complete with switchboard and balancing set. Arthur S. Partridge, 417 Pine St., St. Louis.

ONE 28 HP. Harrisburg automatic 8½x8 engine, direct connected to an 18 kw., 115 volt d.c., Westinghouse generator, $600; excellent condition, taken out to make room for larger unit; price f.o.b. Portsmouth, Ohio. The Selby Shoe Co.

20x40x48", 30x60", 16x32x48", 24x42", 20x42", 18x36", 14x36", 12x24" Corliss engines, 12x20x14 Ideal, 10x11" Chuse, 9x14" straight line, 9x12" Russell, 60x20, 66x20, 72x22 butt strap boilers; heaters, pumps, compressors, etc John Ramming Machine Co., Main St. and Clark Ave., St. Louis, Mo.

ONE 120 kilowatt, a.c., 440 volts, Westinghouse generator, belted to 16x42 Allis Corliss engine, complete with exciter, switchboard and all fittings. One 20 kilowatt, d.c., 230 volt, C. & C. Electric Co. generator, direct connected to 8x10 Allfree engine. All of the above in fine shape. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

500 HORSEPOWER right-hand engine; simple Corliss heavy duty frame, size, 24x48, complete, including flywheel, 18 ft. diameter, grooved for 14 turns 1⅜-in rope, American drive-steam receiver separator, 7-in. steam pipe including one long radius bend and flanges; can be seen in operation at our mill in Mt. Carmel, Ill. Address Bernet Craft & Kauffman Mlg. Co., Office 1036 Pierce Building, St. Louis, Mo.

ONE 500 horsepower Hoppes live steam purifier; one 35 kilowatt General Electric, 230 volt steam turbine and dynamo and switchboard panel; one complete Emerson steam pump, including working barrel, capacity 200 gallons per minute; two Worthington water meters; one iron tank, 60,000 tensile strength, 42" diam. and 9' high; two Bundy traps No. 100 and No. 52 series; two Anderson traps No. 3 and No. 2. All in A-1 condition; will sell cheap. Box 656, Power.

SALE of old material at the Navy Yard, New York, N. Y.—There will be sold at the Navy Yard, New York, material belonging to the Navy, condemned as unfit for use therein, consisting of the following superseded power-plant equipment: Davidson & Blake pumps, Ingersoll-Sergeant air compressors, McIntosh-Seymour engines, Wheeler water filters and heaters, Westinghouse generating sets and motors, etc. The sale will be for cash to the highest bidder by sealed proposals to be opened at 10 a.m., May 27, 1912. Schedules containing form of proposals and terms of sale can be obtained upon application to the Board of Sale, Navy Yard, New York. Beekman Winthrop, Assistant Secretary of the Navy.

Alphabetical Index to Advertisers

	Page
Acme Furnace Equipment Co.	86
Albany Lubricating Co.	67
Alberger Heater Co.	86
Allberger Pump Co.	84
American District Steam Co.	91
American Engine Co.	103
American Engineering Co.	8
American Injector Co.	60
American Mfg. Co.	76
American Metal Hose Co.	62
American Pulley Co.	77
American Radiator Co.	89
American School of Correspondence	59
American Steam Gauge & Valve Mfg. Co.	40, 41
Anderson Co., V. D.	78
Armstrong Cork Co.	96
Armstrong Mfg. Co.	70
Armstrong Mfg. Co., The	86
Ashton Valve Co.	97
Austin Separator Co.	80
Babcock & Wilcox Co., The	94
Ball Engine Co.	106
Barnes Co., W. F. & John	100
Beggs & Co., James	55
Betson Plastic Fire Brick Co.	66
Bignall & Keeler Mfg. Co.	69
Blaisdell-Canady Co.	51
Blake & Knowles Steam Pump Works	88
Bowers Rubber Works	62
Bowser & Co., Inc., S. F.	66
Bristol Co.	4th cover
Brown Hoisting Machinery Co.	90
Bruce-Macbeth Engine Co.	99
Buckeye Engine Co.	101
Buffalo Forge Co.	56
Builders Iron Foundry	98
Burt Mfg. Co., The	14
Cameron Steam Pump Works, A. S.	83
Casey-Hedges Co.	94
Chaplin-Fulton Mfg. Co.	91
Chapman Valve Mfg. Co.	72
Chesterton Co., A. W.	56
Cling-Surface Co.	109
Columbian Rope Co.	76
Connersville Blower Co., The	82
Consolidated Engr. Co.	59
Consolidation Coal Co.	11
Cooper Co., C. & G.	98
Crosby Steam Gage & Valve Co.	97
Curtis & Curtis Co., The	69
Cyclone Grate Bar Co.	85
Dallett Co., Thos. H.	91
Dart Mfg. Co., E. M.	71
Daum Co., A. F.	56
Dean Bros. Steam Pump Works	82
Dearborn Drug & Chemical Works	5
De Laval Steam Turbine Co.	107
Deming Co.	82
Dixon Crucible Co., Jos.	60
Durabla Mfg. Co.	63
Engineers Appliance Co., The	72
Engineer Co.	68
Erie City Iron Works	105
Eureka Packing Co.	57, 63
Fitchburg Steam Engine Co.	100
Garlock Packing Co.	9
General Electric Co.	113
Goetze Gasket & Packing Co.	74
Graver Tank Works, Wm.	90
Green Engineering Co.	86
Greene, Tweed & Co.,	53, 4th cover
Griffith & Wedge Co., The	101
H. & M. Valve Co.	72
Hamler-Eddy Smoke Recorder Co.	92
Hammel Oil Burner Co.	94
Harris Steam Engine Co., W. A.	101
Harrisburg Foundry & Machine Works	101
Harrisburg Mfg. & Boiler Co.	94
Harrison Safety Boiler Works	43
Heine Safety Boiler Co.	95
Hewes & Phillips Iron Wks.	102
Hoffman, Geo. W.	90
Homestead Valve Mfg. Co.	71
Hooven, Owens, Rentschler Co.	101
Hoppes Mfg. Co.	89
Howard Iron Works	70
Hughson Steam Specialty Co.	69
Huyette Co., Inc., Paul B.	92
Ingersoll-Rand Co.	100
International Corr. Schools	47
Jefferson Union Co.	111
Jenkins Bros.	45
Johns-Manville Co., H. W.	65
Keeler Co., E.	92
Kellogg Co., M. W.	70

WHAT AILS THE BOILER?

Boilers suffer from a variety of disorders, but at least 50% of them, the boiler inspection and insurance companies tell us, are due to cold, impure, scale-forming or corrosive boiler feed water.

All such **troubles can be cured easily and inexpensively by the installation of a Cochrane Open Feed Water Heater** to heat the water and drive off corrosive gases and air where the water contains "temporary hardness" only, **or a Sorge-Cochrane Hot Process Water Softening System,** which is like the Cochrane Open Feed Water Heater, only with functions extended to include the automatic feeding of a suitable reagent for correcting "permanent hardness," which causes hard scale and is not cured by heat alone, and proper facilities for settling and filtering out the sludge resulting from the treatment.

According to the nature of the water, one or the other of these appliances will give complete freedom from scale, corrosion and temperature strains, saving at the same time from 10 to 15% of the coal bill due to the better transmission of heat through clean plates, and the utilization of the exhaust steam to heat the boiler feed water.

FILL OUT THE FOLLOWING BLANK, showing what the symptoms are, and we shall be pleased to advise you regarding the treatment, and at the same time to send you our 50-page booklet *"What Scale Does to Boilers,"* and our 150-page book *"Cochrane Heaters and Their Use in Steam Power Plants for Heating and Purifying Water for Boiler Feeding and other Purposes."*

Harrison Safety Boiler Works
17th & Clearfield Sts., Philadelphia, Pa.

CUT OFF ALONG THIS LINE

HARRISON SAFETY BOILER WORKS PHILA., PA.

Kindly send me your book *"What Scale Does To Boilers"* and *"Cochrane Heaters and Their Uses."* The plant with which I am connected contains..... boilers of .....H.P. each. The feed water is at present heated by..... and goes into the boiler at ....° F. We are (are not) troubled by (scale) (corrosion) in the boilers. We have exhaust steam, which could be utilized for heating the water, available from .....
We can also use exhaust steam for (low pressure turbines) (heating) (drying).....

Name..... ....Address .....
Position..... Firm .....

	Page
Kelly Foundry & Mach. Co.	85
Kennedy Valve Mfg. Co...	70
Kennicott Co., The.....	91
Keystone Lubricating Co..	3
Kingsford Foundry & Machine Works.....	93
Kinkead Mfg. Co.....	62
Kroeschell Bros. Co.....	69
Lagonda Mfg. Co....3d cover	
Laidlaw-Dunn-Gordon Co..100	
Liberty Mfg. Co.....	7
Long Grate Bar Co., The..	86
Lunkenheimer Co.....	4
Lytton Mfg. Corporation..	78
McClave-Brooks Co.....	12
McEwen Bros.....	83
McGowan Co., The John H.	82
McGraw-Hill Book Co.....108	
McIntosh, Seymour & Co..101	
McLeod & Henry Co.....	92
Manheim Mfg. & Belting Co.	75
Manzel Bros. Co.....	66
Martin Grate Co.....	87
Mason Regulator Co.....	70
Monarch Valve & Mfg. Co.	72
Morehead Mfg. Co.....	79
Morrin Climax Boiler Co..	94
Murphy Iron Works.....	85
Murray Iron Works Co....100	
Murray Specialty Mfg. Co..	80
Nashua Machine Co.....	78
National Pipe Bending Co.	88
National Tube Co.....	70
New York Belting & Packing Co., Ltd.....	10
Neemes Bros.....	85
Nelson Valve Co.....	73
New Bedford Valve Mfg. Co.	70
New Process Rawhide Co..	76
New York Edison Co.....	96
Newhall Engr. Co., Geo. M.	81
Nicholson & Co., W. H.....	79
Nordberg Mfg. Co.....103	
Ohio Blower Co.....	60
Oil City Boiler Works.....	94
Open Coil Heater & Purifier Co.....	78
Oster Mfg. Co.....	66
P.-K. Engineers.....	56
Parson Mfg. Co.....	85
Patterson & Co., Frank L..	89
Penberthy Injector Co....	13
Pennsylvania Coal & Coke Corporation 112	
Pennsylvania Flexible Metallic Tubing Co.....	98
Perfection Grate Co.....	85
Pierce Co., Wm. B.. 2d cover	
Pittsburgh Valve, Foundry & Construction Co....	71
Power & Mining Mchry. Co.	98
Power Specialty Co.....65,	90
Pratt & Cady Co.....	56
Precision Instrument Co...	91
Prest-O-Lite Co.....	58
Providence Engr. Works..102	
Quaker City Rubber Co....	64
Quimby, Inc., Wm. E.....	82
Reliance Gauge Column Co.	79
Rhoads & Sons, J. E., 1st cover	
Richardson-Phenix Co....	49
Ridgway Dynamo & Engine Co.....102	
Riverside Metal Refining Co.	98
Robb Engineering Co., Ltd.	54
Robertson & Son, Jas. L..	57
Rogers Co., H. A.....	82
Rollins Engine Co.....104	
Rooksby & Co., E. J.....101	
"S-C" Regulator Co.....	65
St. John, G. C.....	74
Salamander Grate Bar Co..	85
Scaife & Sons Co., Wm. B..	90
Schade Valve Mfg. Co.....	71
Schaeffer & Budenberg Mfg. Co.	67
Schieren Co., Chas. A.....	76
Schuchardt & Schütte.....	56
Schutte & Koerting Co....	72
Simonds & Co., G. L.....	69
Simmons Co., John.....	70
Skinner Engine Co.....103	
Smith & Son Co., Samuel..	92
Smooth-On Mfg. Co.....	6
Squires Co., C. E.....	77
Starrett Co., L. S.....	74
Steel Mill Packing Co.....	65
Sterling Machine Co.....	68
Struthers-Wells Co.....	98
Sturtevant Co., B. F.....102	
Terry Steam Turbine Co...	62
Thacher & Co., George H..	61
Treadwell Co., Inc., M. H..	85
Trill Indicator Co.....	76
Trimont Mfg. Co.....	110
Tripp Metallic Packing Co.	65
Turbo-Blower Co.....	90
Turner Fricke Mfg. Co....	98
Uehling Instrument Co....	90
Under-Feed Stoker Co. of America	74
Underwood & Co., H. B..102	
Vanda Co.....	63
Vilter Mfg. Co., The.....102	
Vogt. Mach. Co., Inc., H...	92
Washburn & Granger.....	85
Watson & McDaniel Co....	83
Watts-Campbell Co.....102	
Webster & Co., Warren...	88
Westinghouse Electric & Mfg. Co.....114	
Wheeler Condenser & Engineering Co.....	82
Wheeler Mfg. Co., C. H.,	83
Whitlock Coil Pipe Co....	88
Wickes Boiler Co., The....	94
Williams & Co., J. H.....	97
Wing Mfg. Co., L. J.....	59
Worthington, Henry R....	84
Wright Mfg. Co.....	80
Wyckoff & Son Co., A.....	69
Yarnall-Waring Co.....	71
York Mfg. Co.....103	

Classified Index to Articles Advertised

Air Compressors
Ingersoll-Rand Co.....100
Laidlaw-Dunn-Gordon Co..100
Nordberg Mfg. Co.....103
Vilter Mfg. Co.....102
York Mfg. Co.....103

Air Cooling Apparatus
York Mfg. Co.....103

Alarms, Low Water
Lunkenheimer Co..... 4
Penberthy Injector Co.... 13
Reliance Gauge Column Co. 79
Wright Mfg. Co..... 80

Alternators
General Electric Co.....113

Ash Ejectors
Parsons Mfg. Co..... 85

Belt Dressing
Cling-Surface Co.....109
Dixon Crucible Co., Jos.... 60
Garlock Packing Co..... 9
Keystone Lubricating Co.. 3
Rhoads & Sons, J. E., 1st cover
Robertson & Sons, J. L... 57
Schieren Co., Chas. A..... 76

Belt Lacing
Bristol Co.....4th cover
Rhoads & Sons, J. E., 1st cover
Schieren Co., Chas. A..... 76

Belting
Bowers Rubber Works.... 62
Garlock Packing Co..... 9
Greene, Tweed & Co. 53, 4th cover
Manheim Mfg. & Belting Co. 75
New York Belting & Packing Co., Ltd..... 10
Quaker City Rubber Co... 64
Rhoads & Sons, J. E., 1st cover
Schieren Co., Chas. A..... 76

Blowers, Fan
Beggs & Co., James..... 55
Blaisdell-Canady Co..... 51
Buffalo Forge Co..... 56
McEwen Bros..... 83
Ohio Blower Co..... 60
Sturtevant Co., B. F.....102
Terry Steam Turbine Co.. 62
Turbo-Blower Co..... 90
Wing Mfg. Co., L. J..... 59

Blowers, Steam Jet
McClave-Brooks Co..... 12
Parson Mfg. Co..... 85
Schutte & Koerting Co.... 72

Boiler Compound
Dearborn Drug & Chemical Works 5
Dixon Crucible Co., Jos.... 63
Johns-Manville Co., H. W.. 65
Keystone Lubricating Co.. 3

Boiler Fronts
Casey-Hedges Co..... 94

Boiler Setting
Betson Plastic Fire Brick Co. 66
McLeod & Henry Co..... 92

Boiler Tube Cap Reseating Machines
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7

Boiler Tube Cleaners
Dallett Co., Thos. H..... 91
Johns-Manville Co., H. W.. 65
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7
Parson Mfg. Co..... 85
Pierce Co., Wm. B...2d cover
Robertson & Sons, Jas. L.. 57
Simonds & Co., G. L..... 69
St. John, G. C..... 74

Boiler Tubes
National Tube Co..... 70

Boilers
Beggs & Co., James..... 55
Babcock & Wilcox Co..... 94
Casey-Hedges Co..... 94
Griffith & Wedge Co.....101
Harrisburg Foundry & Machine Works.....101
Harrisburg Mfg. & Boiler Co. 94
Harrison Safety Boiler Works 43
Heine Safety Boiler Co.... 95
Hewes & Phillips Iron Works 102
Keeler Co., E..... 92
Kennicott Co..... 91
Kingsford Foundry & Machine Co..... 93
McEwen Bros..... 83
Morrin Climax Boiler Co.. 94
Murray Iron Works Co....100
Oil City Boiler Works.... 94
Robb Engineering Co., Ltd. 54
Smith & Son Co., Sam'l.... 92
Struthers-Wells Co..... 98
Vilter Mfg. Co.....102
Vogt Mach. Co., Inc., Henry 92
Wickes Boiler Co..... 94

Books
American School of Correspondence 59
International Corr. Schools. 47
McGraw-Hill Book Co....108

Brick, Fire
Betson Plastic Fire Brick Co. 66
McLeod & Henry Co..... 92

Calorimeters
American Steam Gauge & Valve Mfg. Co.....40, 41
Schaeffer & Budenberg Mfg. Co..... 67

Castings, Brass and Iron
Bruce-Macbeth Eng. Co... 99
Builders' Iron Foundry... 98
Griffiths & Wedge Co.....101
Homestead Valve Mfg. Co. 71
Hooven, Owens, Rentschler Co. 101
Lunkenheimer Co..... 4
McClave-Brooks Co..... 12
Neemes Bros..... 85
Thacher & Co., George H.. 61
Treadwell Co., Inc., M. H.. 85

Castings, Steel
Hooven, Owens, Rentschler Co. 101
Thacher & Co., George H.. 61
Treadwell Co., Inc., M. H.. 85

Cement, Iron
Johns-Manville Co., H. W.. 65
Smooth-On Mfg. Co..... 6

Chimneys, Brick
Kellogg Co., M. W..... 70

Chimneys, Steel
Graver Tank Works, Wm.. 90
Keeler Co., E..... 92

Clocks
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The.... 97

Coal
Consolidation Coal Co.... 11
Pennsylvania Coal & Coke Corporation 112

Coal and Ash Handling Machinery
Brown Hoisting Mchry. Co. 90
Green Engineering Co.... 86
Parson Mfg. Co..... 85

Cocks, Gage
American Steam Gauge & Valve Mfg. Co.....40, 41
Chaplin-Fulton Mfg. Co... 91
Huyette Co., Inc., Paul B.. 92
Jenkins Bros..... 45
Lunkenheimer Co..... 4
Ohio Blower Co..... 60
Penberthy Injector Co.... 13
Reliance Gauge Column Co. 79
"S-C" Regulator Co..... 65
Wright Mfg. Co..... 80

Cocks, Steam
Dart Mfg. Co., E. M..... 71
Lunkenheimer Co..... 4
National Tube Co..... 70
Pratt & Cady Co..... 56
Robertson & Sons, Jas. L.. 57
Schutte & Koerting Co.... 72

Cold Storage Plants
York Mfg. Co.....103

Combustion Chamber, Back Arch
Betson Plastic Fire Brick Co. 66
McLeod & Henry Co..... 92

Combustion Recorders
Precision Instrument Co.. 91
Uehling Instrument Co.... 90

Compound, Commutator
Dixon Crucible Co., Jos... 60

Condensers
Alberger Pump Co..... 84
Anderson Co., V. D..... 78
Cameron Steam Pump Works, A. S..... 83
Connersville Blower Co., The 82
Dean Bros. Steam Pump Works 82
Kellogg Co., M. W..... 70
McGowan Co., John H.... 82
Schutte & Koerting Co.... 72
Wheeler Condenser & Engineering Co..... 82
Wheeler Mfg. Co., C. H... 83
York Mfg. Co.....103

Controllers, Electric
General Electric Co.....113
Westinghouse Electric & Mfg. Co.....114

Controllers, Feed Water
Chaplin-Fulton Mfg. Co... 91
Lagonda Mfg. Co.....3d cover
Mason Regulator Co..... 70
Squires Co., C. E..... 77

Cooling Plants
Power Specialty Co.....65, 90
Schutte & Koerting Co.... 72

Cooling Towers
Wheeler Condenser & Engineering Co..... 82

Correspondence Schools
American School of Correspondence 59
International Corr. Schools. 47

Couplings, Pipe
Pratt & Cady Co..... 56

Couplings, Flexible Shaft
Bruce-Macbeth Engine Co. 99
Hooven, Owens, Rentschler Co. 101
McEwen Bros..... 83

Covering, Pipe
Wyckoff & Son Co., A..... 69

Covering, Pipe and Boiler
Armstrong Cork Co..... 96
Johns-Manville Co., H. W.. 65

Crank Pin Oiler
Albany Lubricating Co.... 67
Richardson-Phenix Co.... 49

Crank Pin Turning Machines, Portable
Underwood & Co., H. B...102

Curbs, Manhole
Armstrong Mfg. Co..... 70

Say, Mr. Dealer, Send Me Some More

Jenkins '96

IT does not matter how you order Jenkins '96 Packing—by mail, telephone, telegraph, or over the counter—as long as you get it.

It's getting the genuine that is important, for when you get the genuine you get a packing that's soft and flexible enough to fill up any roughness of the surface—

That's strong enough to hold its own against steam, water, acid or ammonia—

That makes tight and permanent joints which do not burn or blow out.

Your dealer will be glad to supply you. Write to us direct for a copy of our latest catalog.

Jenkins Bros.

New York, 80 White Street
Philadelphia, 135 North Seventh Street

Boston, 35 High Street
Chicago, 300 West Lake Street

REG. U.S. PAT. OFF. TRADE JENKINS MARK Jenkins Bros.

REG. U.S. PAT. OFF. TRADE JENKINS MARK Jenkins Bros.

Cylinder Boring Bars
Rooksby & Co., E. J.....101
Underwood & Co., H. B...102

Cylinders, Rebored
Rooksby & Co., E. J.....101
Underwood & Co., H. B....102

Dash Pots
Underwood & Co., H. B....102

Die Stocks
Armstrong Mfg. Co..... 70
Bignall & Keeler Mfg. Co. 69
Curtis & Curtis Co..... 69
Oster Mfg. Co..... 66

Draft, Mechanical
Blaisdell-Canady Co..... 51
Buffalo Forge Co..... 56
Engineer Co..... 68
Parson Mfg. Co..... 85
Schutte & Koerting Co.... 72
Sturtevant Co., B. F.....102
Thacher & Co., George H.. 61
Turbo-Blower Co..... 90
Wing Mfg. Co., L. J..... 59

Drills, Upright
Barnes Co., W. F. & John..100

Dust Collectors
Ohio Blower Co..... 60
Schutte & Koerting Co.... 72
Sturtevant Co., B. F.....102

Dynamos
American Engine Co.....103
Bruce-Macbeth Eng. Co... 99
General Electric Co.....113
Ridgway Dynamo & Engine Co.....102
Terry Steam Turbine Co... 62
Westinghouse Electric & Mfg. Co.....114

Economizers, Fuel
Parson Mfg. Co..... 85
Sturtevant Co., B. F.....102
Thacher & Co., George H.. 61

Ejectors
American Injector Co..... 60
Beggs & Co., James..... 55
Lunkenheimer Co..... 4
Penberthy Injector Co.... 13
Schutte & Koerting Co... 72

Electric Current
New York Edison Co..... 96

Eliminators, Steam
Nicholson & Co., W. H..... 79

Engine Hoists
Nordberg Mfg. Co.....103

Engine Repairs
Rooksby & Co., E. J.....101
Underwood, H. B.....102

Engine Stops
Schutte & Koerting Co... 72

Engines, Combustion
Beggs & Co., James..... 55
Bruce-Macbeth Eng. Co... 99
Buckeye Engine Co.....101
Power & Mining Mchry. Co. 98
Struthers-Wells Co..... 98
Turner Fricke Mfg. Co... 98

Engines, Pumping
Hooven, Owens, Rentschler Co.....101
McGowan Co., John H..... 82
Nordberg Mfg. Co.....103

Engines, Steam
American Engine Co.....103
Ball Engine Co.....106
Beggs & Co., James..... 55
Buckeye Engine Co.....101
Buffalo Forge Co..... 56
Cooper Co., C. & G..... 98
Erie City Iron Works.....105
Fitchburg Steam Engine Co.....100
Griffith & Wedge Co.....101
Harris Steam Engine Co..101
Harrisburg Foundry & Machine Works.....101
Hewes & Phillips Iron Works 102
Hooven, Owens, Rentschler Co.....101
McIntosh, Seymour & Co..101
Murray Iron Works Co....100
Nordberg Mfg. Co.....103
Providence Engr. Works..102
Ridgeway Dynamo & Engine Co.....102
Rollins Engine Co.....104
Skinner Engine Co.....103

Engines, Steam—Continued
Sterling Machine Co..... 68
Sturtevant Co., B. F.....102
Vilter Mfg. Co.....102
Watts-Campbell Co.....102

Exhaust Heads
Burt Mfg. Co..... 14
Hoppes Mfg. Co..... 89
Ohio Blower Co..... 60
Patterson & Co., Frank L. 89
Robertson & Sons, Jas. L.. 57
Sturtevant Co., B. F.....102
Watson & McDaniel Co... 83
Whitlock Coil Pipe Co.... 88
Wright Mfg. Co..... 80

Expansion Joints
Greene, Tweed & Co., 53, 4th cover
National Tube Co..... 70
P.-K. Engineers..... 56
Webster & Co., Warren.... 88

Fans, Electric
General Electric Co.....113
Sturtevant Co., B. F.....102
Westinghouse Electric & Mfg. Co.....114
Wing Mfg. Co., L. J..... 59

Fans, Exhaust and Ventilating
Anderson Co., V. D..... 78
Buffalo Forge Co..... 56
General Electric Co.....113
Power Specialty Co.....65, 90
Sturtevant Co., B. F.....102
Turbo-Blower Co..... 90
Wing Mfg. Co., L. J..... 59

Feeders, Boiler Compound
Richardson-Phenix Co.... 49

Feeders, Furnace
Ohio Blower Co..... 60

Filters, Oil
Burt Mfg. Co..... 14
Richardson-Phenix Co.... 49
Robertson & Sons, Jas. L.. 57
Wright Mfg. Co..... 80

Filters, Water
Beggs & Co., James..... 55
Scaife & Sons Co., Wm. B.. 90

Fire Clay
Betson Plastic Fire Brick Co. 66
McLeod & Henry Co..... 92

Firebox Blocks
Betson Plastic Fire Brick Co. 66
McLeod & Henry Co..... 92

Fittings, Ammonia
American Steam Gauge & Valve Mfg. Co.....40, 41
Greene, Tweed & Co., 53, 4th cover

Fittings, Steel
Lunkenheimer Co..... 4
Nelson Valve Co..... 73

Flanges
Dart Mfg. Co., E. M..... 71
Jefferson Union Co.....111
National Tube Co..... 70

Floats
Anderson Co., V. D..... 78
Reliance Gauge Column Co. 79

Flue Gas Analysis Instruments
Pierce Co., Wm. B...2d cover
Precision Instrument Co.. 91

Forgings, Drop
Williams & Co., J. H..... 97

Furnace Door Arch
McLeod & Henry Co..... 92

Furnaces, Smokeless
McClave-Brooks Co..... 12
Murphy Iron Works..... 85

Fuse Shells, Cartridge
Daum Co., A. F..... 56

Gage Boards
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The.... 97

Gage Glasses
American Steam Gauge & Valve Mfg. Co.....40, 41
Durabla Mfg. Co..... 63
Garlock Packing Co..... 9
Penberthy Injector Co.... 13
Quaker City Rubber Co... 64
Rogers Co., H. A..... 82
Schaeffer & Budenberg Mfg. Co..... 67

Gage Testing Outfit
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The..... 97
Schaeffer & Budenberg Mfg. Co..... 67

Gages, Draft
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The.... 97
Bristol Co.....4th cover
Precision Instrument Co.. 91
Schaeffer & Budenberg Mfg. Co..... 67

Gages, Pressure
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The..... 97
Crosby Steam Gage & Valve Mfg. Co..... 97
Keeler Co., E..... 92
Schaeffer & Budenberg Mfg. Co..... 67

Gages, Recording
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The..... 97
Bristol Co.....4th cover
Precision Instrument Co.. 91
Schaeffer & Budenberg Mfg. Co..... 67
Uehling Instrument Co.... 90

Gages, Vacuum
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The.... 97
Greene, Tweed & Co., 53, 4th cover
Precision Instrument Co... 91
Schaeffer & Budenberg Mfg. Co..... 67
Schutte & Koerting Co.... 72

Gages, Water
American Steam Gauge & Valve Mfg. Co.....40, 41
Crosby Steam Gauge & Valve Mfg. Co..... 97
Greene, Tweed & Co., 53, 4th cover
Huyette Co., Inc., Paul B.. 92
Jenkins Bros..... 45
Lunkenheimer Co..... 4
Ohio Blower Co..... 60
Penberthy Injector Co..... 13
Reliance Gauge Column Co. 79
Schaeffer & Budenberg Mfg. Co..... 67
Wright Mfg. Co..... 80

Gas Exhausters
Ohio Blower Co..... 60
Parson Mfg. Co..... 85

Gas Producers
Power & Mining Mchry. Co. 98

Gaskets
Eureka Packing Co.....57, 63
Garlock Packing Co..... 9
Goetze Gasket & Packing Co. 74
Greene, Tweed & Co., 53, 4th cover
Jenkins Bros..... 45
Johns-Manville Co., H. W.. 65
Keeler Co., E..... 92
New York Belting & Packing Co., Ltd..... 10
Quaker City Rubber Co... 64
Smooth-On Mfg. Co..... 6
Vanda Co..... 63

Gears
New Process Raw Hide Co. 76

Generating Sets
American Engine Co.....103
General Electric Co.....113
Harris Steam Engine Co..101
Harrisburg Foundry & Machine Works.....101
Ridgway Dynamo & Engine Co.....102
Sturtevant Co., B. F.....102
Westinghouse Electric & Mfg. Co.....114

Governors, Pump
Chaplin-Fulton Mfg. Co... 91
Hughson Steam Specialty Co. 69
Mason Regulator Co..... 70
"S-C" Regulator Co..... 65
Schade Valve Mfg. Co.... 71
Squires Co., C. E..... 77
Watson & McDaniel Co... 83

Governors, Pump Speed
Mason Regulator Co..... 70

Graphite
Dixon Crucible Co., Jos... 60
Garlock Packing Co..... 9
Greene, Tweed & Co., 53, 4th cover

Grates
Acme Furnace Equipment Co. 86
Armstrong Mfg. Co..... 86
Babcock & Wilcox Co..... 94
Beggs & Co., James..... 55
Casey-Hedges Co..... 94
Cyclone Grate Bar Co..... 85
Kelly Foundry & Machine Co. 85
Long Grate Bar Co..... 86
McClave-Brooks Co..... 12
Martin Grate Co..... 87
Neemes Bros..... 85
Perfection Grate Co..... 85
Robb Engineering Co., Ltd. 54
Robertson & Sons, Jas. L.. 57
Salamander Grate Bar Co. 85
Thacher & Co., Geo. H.... 61
Treadwell Co., Inc., M. H.. 85
Washburn & Granger Co.. 85

Grease
Albany Lubricating Co.... 67
Dearborn Drug & Chemical Works 5
Dixon Crucible Co., Jos... 60
Keystone Lubricating Co.. 3

Grease Extractors
American Steam Gauge & Valve Mfg. Co.....40, 41
Beggs & Co., James..... 55

Heaters and Purifiers, Feed Water
Alberger Heater Co..... 86
Alberger Pump Co..... 84
Blake & Knowles Steam Pump Works..... 88
Casey-Hedges Co..... 94
Graver Tank Works, Wm.. 90
Harrison Safety Boiler Works 43
Hoppes Mfg. Co..... 89
National Pipe Bending Co. 88
Open Coil Heater & Purifier Co..... 78
Patterson & Co., Frank L.. 89
Robertson & Sons, Jas. L.. 57
Scaife & Sons Co., Wm. B.. 90
Schutte & Koerting Co.... 72
Sturtevant Co., B. F.....102
Webster & Co., Warren.... 88
Wheeler Mfg. Co., C. H.... 83
Whitlock Coil Pipe Co.... 88
Wickes Boiler Co..... 94

Heating & Ventilating Systems
Consolidated Engr. Co..... 59
Ohio Blower Co..... 60
Schutte & Koerting Co.... 72
Sturtevant Co., B. F.....102
Webster & Co., Warren.... 88
Wing Mfg. Co., L. J..... 59

Heating, Central Station
American District Steam Co. 91

Hoists, Electric
Brown Hoisting Machinery Co. 90

Hose, Metal
American Metal Hose Co.. 62
Pennsylvania Flexible Metallic Tubing Co..... 98

Hose, Rubber
Garlock Packing Co..... 9
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7
New York Belting & Packing Co., Ltd..... 10
Quaker City Rubber Co... 64

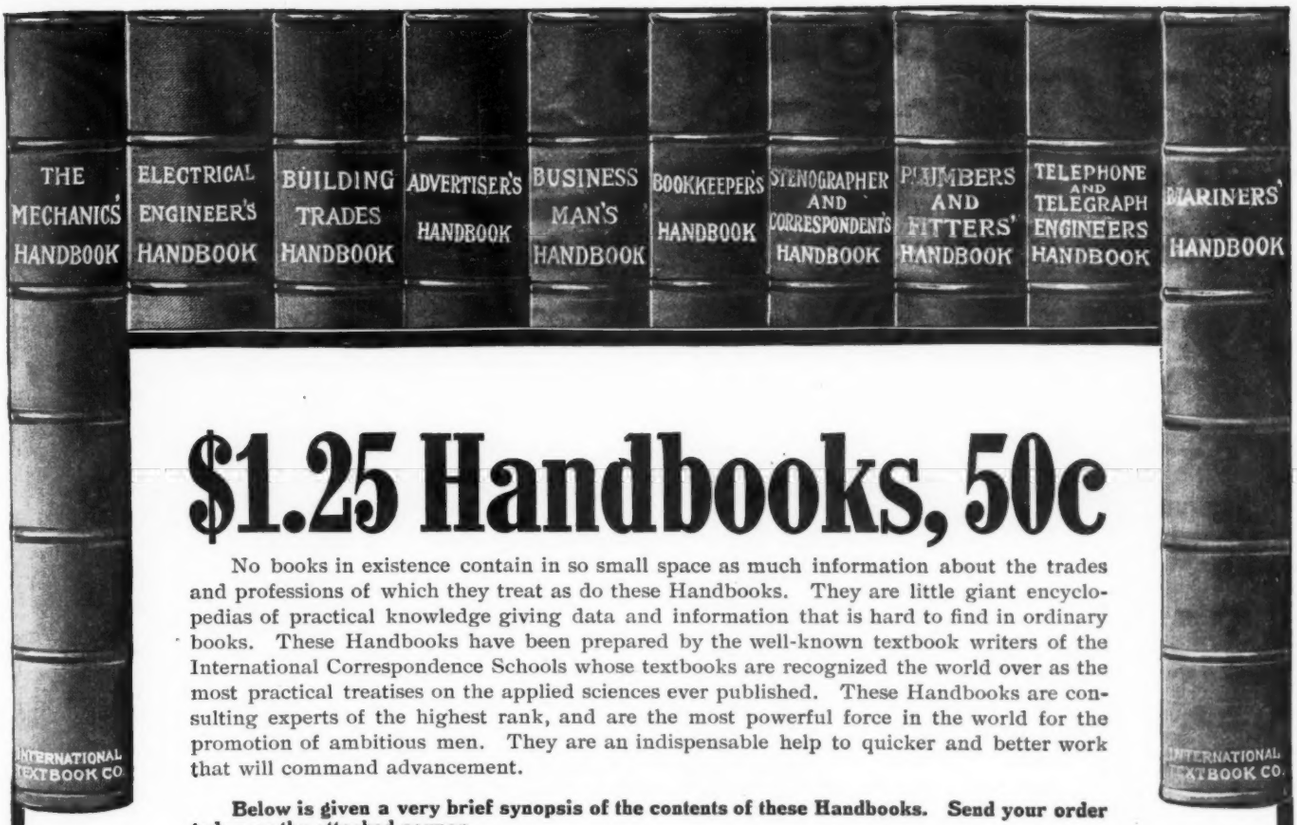
Ice and Refrigerating Machinery
Vilter Mfg. Co.....102
Vogt Machine Co., Henry.. 92
Watts-Campbell Co.....102
York Mfg. Co..... 103

Ice Machine Repairs
Underwood & Co., H. B...102

Indicators, Ammonia
American Steam Gauge & Valve Mfg. Co.....40, 41
Schaeffer & Budenberg Mfg. Co..... 67

Indicators, Combustion Engine
American Steam Gauge & Valve Mfg. Co.....40, 41
Trill Indicator Co..... 76

Indicators, Flow
Richardson-Phenix Co..... 49



$1.25 Handbooks, 50c

No books in existence contain in so small space as much information about the trades and professions of which they treat as do these Handbooks. They are little giant encyclopedias of practical knowledge giving data and information that is hard to find in ordinary books. These Handbooks have been prepared by the well-known textbook writers of the International Correspondence Schools whose textbooks are recognized the world over as the most practical treatises on the applied sciences ever published. These Handbooks are consulting experts of the highest rank, and are the most powerful force in the world for the promotion of ambitious men. They are an indispensable help to quicker and better work that will command advancement.

Below is given a very brief synopsis of the contents of these Handbooks. Send your order today on the attached coupon.

Mechanics'.—Tables; formulas; measurements; belting; mechanical powers; hydromechanics; strength of materials; shafting; boiler design; care of boilers; power of boilers; chimneys; exhaust heating; machine design; machine tools; slide valve; pulleys; cylinders and steam chests; pistons; gearing; transit surveying; triangulation; curves; radii and deflections; earth work; track work; electricity; etc.

Electrical Engineer's.—Mechanics; electrical units; physical and electrical properties of metals and alloys; temperature for copper wires; wire gauges; magnetism; dynamos and motors; electric batteries; alternating current apparatus; alternators; transformers; wattmeters; electric transmission: electric lamps; wiring; electric heating and welding; electromagnets; controllers; car wiring; etc.

Building Trades.—Loads and structures: strength of materials; properties of sections; strength of rivets and pins; materials of construction; footings and foundations; masonry construction; woods used in building; qualities of timbers; joinery; framing; estimating; elements of architectural design; drainage systems; plumbing fixtures; plumbers' tables; heating and ventilation; gas-fitting; etc.

Advertiser's.—How to plan and write an advertisement; type and type measurement; points on printing style; advertisement display; preparation of manuscript; proof reading; engraving and printing methods; electrotypes; matrices; advertisement illustrations; magazines; newspapers; retail, department-store, general, trade-paper, and mail-order advertising; trade marks; circulars; advertising agencies, etc.

Business Man's.—Arithmetic; tables; business forms; card systems; measures of extension; weight and capacity; time; value of foreign coins; duties on imports; bookkeeping; stenography; correspondence; postal information; financial terms; money and the money market; brokers and brokerage; patents; copyright and trade marks; corporations; business law; publicity; etc.

Mariners'.—Useful tables; logarithms; trigonometry; navigation; terrestrial navigation; celestial navigation; sailing distances; U. S. Navy; classification of war ships; organization of a man of war; naval ordnance; explosives; torpedoes; ship building; speed, tonnage, and fuel consumption; ropes; wind and weather; signals; nautical memoranda; U. S. naturalization laws; custom-house fees, etc.

Stenographer's & Correspondent's

Advice to beginners; shorthand speed; technical terms; commonly used foreign words and phrases; letters of application; punctuation; correct and faulty diction; business correspondence; typewriting; abbreviations; addressing; mailing; rates of postage; modern office methods; typewriting forms; duplicating work; etc.

Plumbers and Fitters'.—Arithmetic; involution and evolution; powers, roots, and reciprocals; table of circles; decimals; geometrical drawing; weights and measures; mechanical powers; blue prints; formulas; mensuration; mechanics; hydromechanics; building construction; heating and ventilation; gas and gas-fitting; plumbing; etc.

Telephone and Telegraph.—Useful tables; powers, roots, and reciprocals; mechanics; electricity; magnetism; primary batteries; storage batteries; electrical measurements; telephony; tests with magneto-generator and bell; telegraphy; Morse telegraph systems; multiplex telegraphy; simultaneous telegraphy and telephony; etc.

Bookkeeper's.—Arithmetic; formulas; tables; money; percentage; interest; equation of accounts; money and the money market; business law; financial terms; banks and banking; postal information; distances and time between various places; bookkeeping; business forms; card systems; modern office methods; cost accounting; bank bookkeeping; clearing-house methods; etc.

SPECIAL OFFER.—For a limited time we are selling these Handbooks durably bound in cloth, with gilt titles, containing on an average of 375 pages and 175 illustrations, and regularly sold at $1.25, at a price for each Handbook of . . . 50c

International Textbook Company

Box 979, SCRANTON, PA.

I enclose $_____ for which please send me the books **BEFORE** which I have marked **X**.

__Mechanics' Handbook	__Advertiser's Handbook
__Electrical Engineer's Handbook	__Bookkeeper's Handbook
__Building Trades Handbook	__Steno. & Corr. Handbook
__Plumbers & Fitters' Handbook	__Business Man's Handbook
__Tel. & Tel. Handbook	__Mariners' Handbook

*Name*_____

*Street and No.*_____

*City*_____ *State*_____

Indicators, Gas Engine
Trill Indicator Co..... 76

Indicators, Speed
American Steam Gauge & Valve Mfg. Co.....40, 41
Starrett Co., L. S..... 74

Indicators, Steam Engine
American Steam Gauge & Valve Mfg. Co.....40, 41
Crosby Steam Gage & Valve Co. 97
Robertson & Sons, Jas. L.. 57
Schaeffer & Budenberg Mfg. Co..... 67
Trill Indicator Co..... 76

Injectors
American Injector Co..... 60
Jenkins Bros..... 45
Lunkenheimer Co..... 4
Penberthy Injector Co.... 13
Robertson & Sons, Jas. L.. 57
Schutte & Koerting Co.... 72

Lamps, Arc
General Electric Co.....113
Westinghouse Electric & Mfg. Co.....114

Lamps, Incandescent
General Electric Co.....113
Johns-Manville Co., H. W.. 65
Westinghouse Electric & Mfg. Co.....114

Lathes, Foot Power
Barnes Co., W. F. & John..100

Lubricators, Cylinder
Albany Lubricating Co.... 67
Greene, Tweed & Co., 53, 4th cover
Keystone Lubricating Co.. 3
Lunkenheimer Co..... 4
Manzel Bros. Co..... 66
Penberthy Injector Co.... 13
Richardson-Phenix Co..... 49
Robertson & Son, Jas. L.. 57
Sterling Machine Co..... 68

Lubricators, Force Feed
Greene, Tweed & Co., 53, 4th cover
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 49
Sterling Machine Co..... 68

Mats and Matting
New York Belting & Packing Co., Ltd..... 10

Metal, Bearing
Riverside Metal Refining Co. 98

Meters, Steam
St. John, G. C..... 74

Meters, Water
Builders Iron Foundry.... 98
St. John, G. C..... 74
Harrison Safety Boiler Works 43

Micrometers
Starrett Co., L. S..... 74

Milling Machines, Portable
Underwood & Co., H. B....102

Motors, Electric
American Engine Co.....103
General Electric Co.....113
Ridgway Dynamo & Engine Co.....102
Sturtevant Co., B. F.....102
Westinghouse Electric & Mfg. Co.....114

Motors, Water
Liberty Mfg. Co..... 7
Lagonda Mfg. Co....3d cover

Oil and Grease Cups
Albany Lubricating Co... 67
American Injector Co..... 60
Keystone Lubricating Co.. 3
Lunkenheimer Co..... 4
Penberthy Injector Co.... 13
Schaeffer & Budenberg Mfg. Co..... 67

Oil Burners
Hammel Oil Burner Co.... 94
Parson Mfg. Co..... 85

Oil Reservoirs
Bowser & Co., Inc., S. F... 66
Burt Mfg. Co..... 14
Graver Tank Works, Wm. 90
Richardson-Phenix Co..... 49

Oil Tanks
Bowser & Co., Inc., S. F... 66
Graver Tank Works, Wm. 90
Richardson-Phenix Co..... 49

Oilers, Telescopic
Penberthy Injector Co.... 13

Oiling Devices
Albany Lubricating Co.... 67
Lunkenheimer Co..... 4
Penberthy Injector Co..... 13
Richardson-Phenix Co..... 49
Sterling Machine Co..... 68

Oiling Systems
Albany Lubricating Co.... 67
Bowser & Co., Inc., S. F... 66
Burt Mfg. Co..... 14
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 49
Sterling Machine Co..... 68

Oils
Albany Lubricating Co.... 67
Dearborn Drug & Chemical Works 5

Packing, Cylinder
Rooksby & Co., E. J.....101
Underwood & Co., H. B...102

Packing, Flange
Bowers Rubber Works.... 62
Durabla Mfg. Co..... 63
Eureka Packing Co.....57, 63
Garlock Packing Co..... 9
Goetze Gasket & Packing Co. 74
Greene, Tweed & Co., 53, 4th cover
Jenkins Bros..... 45
Johns-Manville Co., H. W.. 65
Keeler Co., E..... 92
New York Belting & Packing Co., Ltd..... 10
Quaker City Rubber Co... 64
Smooth-On Mfg. Co..... 6

Packing, Hydraulic
Chesterton Co., A. W..... 56
Durabla Mfg. Co..... 63
Eureka Packing Co.....57, 63
Garlock Packing Co..... 9
Goetze Gasket & Packing Co. 74
Johns-Manville Co., H. W.. 65
P.-K. Engineers..... 56
Quaker City Rubber Co... 64
Schieren Co., Chas. A..... 76
Steel Mill Packing Co.... 65

Packing, Metallic
Goetze Gasket & Packing Co. 74

Packing, Pump Valve
Durabla Mfg. Co..... 63
Quaker City Rubber Co... 64

Packing, Rod
Bowers Rubber Works.... 62
Chesterton Co., A. W..... 56
Durabla Mfg. Co..... 63
Eureka Packing Co.....57, 63
Garlock Packing Co..... 9
Goetze Gasket & Packing Co. 74
Greene, Tweed & Co., 53, 4th cover
Johns-Manville Co., H. W.. 65
New York Belting & Packing Co., Ltd..... 10
Power Specialty Co.....65, 90
Quaker City Rubber Co... 64
Steel Mill Packing Co..... 65
Tripp Metallic Packing Co. 65
Vanda Co..... 63

Packing, Sheet
Vanda Co..... 63

Packing, Valve Stem
Eureka Packing Co.....57, 63
Garlock Packing Co..... 9
Greene, Tweed & Co., 53, 4th cover
Tripp Metallic Packing Co. 65
Vanda Co..... 63

Pipe
Harrisburg Mfg. & Boiler Co. 94
Kellogg Co., M. W..... 70
National Tube Co..... 70

Pipe Bending
National Pipe Bending Co. 88
Kellogg Co., M. W..... 70
Whitlock Coil Pipe Co.... 88

Pipe Clamp
Yarnall-Waring Co..... 71

Pipe Coils
National Pipe Bending Co. 88
National Tube Co..... 70
Whitlock Coil Pipe Co.... 88

Pipe Cutting and Threading Machines
Armstrong Mfg. Co..... 70
Bignall & Keeler Mfg. Co. 69
Curtis & Curtis Co..... 69
Oster Mfg. Co..... 66
Treadwell Co., Inc., M. H.. 85
Trimont Mfg. Co.....110
Williams & Co., J. H..... 97

Pipe Fittings
Jefferson Union Co.....111
Lunkenheimer Co..... 4
National Tube Co..... 70
Pittsburg Valve Foundry & Construction Co..... 71
Trimont Mfg. Co.....110

Pipe, Joint Compound
Dixon Crucible Co., Jos... 60

Pipe, Riveted Steel
Graver Tank Works, Wm. 90
Harrisburg Mfg. & Boiler Co. 94

Pipe, Welded & Seamless
National Tube Co..... 70

Piping, Blower
Ohio Blower Co..... 60

Piping, High Pressure
Kellogg Co., M. W..... 70
Whitlock Coil Pipe Co.... 88

Planimeters
American Steam Gauge & Valve Mfg. Co.....40, 41
Robertson & Sons, Jas. L.. 57
Schaeffer & Budenberg Mfg. Co..... 67
Trill Indicator Co..... 76

Plumbago
Dixon Crucible Co., Jos... 60

Polish, Metal
Hoffman, Geo. W..... 90
Johns-Manville Co., H. W.. 65

Publishers
American School of Correspondence 59
International Corr. Schools. 47
McGraw-Hill Book Co.....108

Pulleys
American Pulley Co..... 77
Greene, Tweed & Co., 53, 4th cover

Pumps, Air
Cameron Steam Pump Works, A. S..... 83
Dean Bros. Steam Pump Works 82
Deming Co..... 82
McGowan Co., John H..... 82
Wheeler Cond. & Engr. Co. 82
Wheeler Mfg. Co., C. H... 83

Pumps, Centrifugal
Alberger Pump Co..... 84
Buffalo Forge Co..... 56
De Laval Steam Turbine Co.107
Deming Co..... 82
Quimby, Inc., Wm. E..... 82
Terry Steam Turbine Co.. 62
Worthington, Henry R.... 84

Pumps, Deep Well
Cameron Steam Pump Works, A. S..... 83
Dean Bros. Steam Pump Works 82
Deming Co..... 82
McGowan Co., John H..... 82

Pumps, Electric
Cameron Steam Pump Works, A. S..... 83
De Laval Steam Turbine Co.107
Deming Co..... 82
Quimby, Inc., Wm. E..... 82

Pumps, Force Feed
Richardson-Phenix Co..... 49

Pumps, Jet
Dean Bros. Steam Pump Works 82
McGowan Co., John H..... 82

Pumps, Oil
Burt Mfg. Co..... 14
Cameron Steam Pump Works, A. S..... 83
Deming Co..... 82
Lunkenheimer Co..... 4
Manzel Bros. Co..... 66
Patterson & Co., Frank L.. 89
Quimby, Inc., Wm. E..... 82
Richardson-Phenix Co..... 49
Sterling Machine Co..... 68

Pumps, Oil Force-feed
Lunkenheimer Co..... 4
Richardson-Phenix Co.... 49
Sterling Machine Co..... 68

Pumps, Pneumatic
Ingersoll-Rand Co.....100

Pumps, Power
Cameron Steam Pump Works, A. S..... 83
Dean Bros. Steam Pump Works 82
Deming Co..... 82
Patterson & Co., Frank L.. 89
Quimby, Inc., Wm. E..... 82
Wheeler Mfg. Co., C. H... 83
Whitlock Coil Pipe Co.... 88

Pumps, Screw
Quimby, Inc., Wm. E..... 82

Pumps, Steam
Cameron Steam Pump Works, A. S..... 83
De Laval Steam Turbine Co.107
Dean Bros. Steam Pump Works 82
Deming Co..... 82
Ingersoll-Rand Co.....100
McGowan Co., John H..... 82
Mason Regulator Co..... 70
Wheeler Condenser & Engineering Co..... 82
Wheeler Mfg. Co., C. H... 83
Worthington, Henry R.... 84

Pumps, Turbine
De Laval Steam Turbine Co.107
McEwen Bros..... 83

Pumps, Vacuum
Alberger Pump Co..... 84
Cameron Steam Pump Works, A. S..... 83
Connersville Blower Co., The 82
Dean Bros. Steam Pump Works 82
McGowan Co., John H..... 82
Wheeler Cond. & Engr. Co. 82
Wheeler Mfg. Co., C. H.... 83

Pyrometers
American Steam Gauge & Valve Mfg. Co.....40, 41
Schaeffer & Budenberg Mfg. Co..... 67

Rams, Steam
Penberthy Injector Co.... 13

Reducing Wheels
American Steam Gauge & Valve Mfg. Co.....40, 41
Robertson & Sons, Jas. L.. 57
Trill Indicator Co..... 76

Regulators, Damper
Blaisdell-Canady Co..... 51
Lagonda Mfg. Co....3d cover
Mason Regulator Co..... 70
Robertson & Sons, Jas. L.. 57
Schaeffer & Budenberg Mfg. Co..... 67
"S-C" Regulator Co..... 65
Turbo-Blower Co..... 90
Wing Mfg. Co., L. J..... 59

Regulators, Feed Water
American District Steam Co. 91
Harrison Safety Boiler Works 43
Lagonda Mfg. Co....3d cover
Mason Regulator Co..... 70
Murray Specialty Mfg. Co.. 80
"S-C" Regulator Co..... 65
Squires Co., C. E..... 77
Wing Mfg. Co., L. J..... 59

Regulators, Pressure
American District Steam Co. 91
Chaplin-Fulton Mfg. Co... 91
Hughson Steam Specialty Co. 69
Lagonda Mfg. Co....3d cover
Lytton Mfg. Corporation.. 78
Mason Regulator Co..... 70
Robertson & Sons, Jas. L.. 57
Squires Co., C. E..... 77
Watson & McDaniel Co.... 83

Regulators, Pump
Hughson Steam Specialty Co. 69
Mason Regulator Co..... 70
Squires Co., C. E..... 77
"S-C" Regulator Co..... 65

Regulators, Tank
American Radiator Co.... 89

Revolution Counters
American Steam Gauge & Valve Mfg. Co.....40, 41
Ashton Valve Co., The.... 97
Schuchardt & Schütte..... 56
Starrett Co., L. S..... 74